METHODS OF PRECISION IN THE INVESTIGATION OF DISORDERS OF DIGESTION

By J. H. Kellogg, M. D.

Superintendent of the Sanitarium at Battle Creek, Mich., Member of the American Medical Association, Michigan State Medical Society, American Public Health Association, British and American Associations for the Advancement of Science, American Microscopical Society, American Social Science Association, Mississippi Valley Medical Association, Societé D' Hygiene of France, British Gynecological Society, and of the International Periodical Gynecological Congress.

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It is not my purpose to undertake to survey, within the narrow limits of this paper, the whole field of gastric pathology as related to diagnosis. I shall only call attention to some of the newer methods of diagnosis relating to functional disorders of the stomach, particularly disturbances of the chemico-vital processes of digestion, by means of which exact, rather than merely presumptive, data may be secured upon which to base a rational mode of treatment in each individual case. The desirability of more precise methods than those which have been heretofore employed, has long been felt by all intelligent practitioners. In no class of curable diseases does the physician, even though aided by the skill acquired by long experience, find himself so often completely baffled as in the treatment of the functional disorders of digestion.

While it is doubtless true that the difficulty of inducing a patient to follow the dietetic prescriptions requisite for a cure, is often responsible for failure, as well as the inability of the physician to make an exact diagnosis of the morbid condition present, it is, perhaps, equally true that our inability to command obedience on the part of our patients is not infrequently the result of our frequent blunders, which lessen the confidence of our patients in our ability to prescribe a dietetic regimen with efficient accuracy.

A patient who has for weeks or months faithfully carried out the dietetic directions arranged for him by his physician, but finds himself still suffering from the same disorders as at the beginning, if, happily, his sufferings have not been aggravated by the experimentation to which he has been subjected,

naturally becomes skeptical of the practical value of "dieting," and perhaps loses respect altogether for the science of medical dietetics. It is no wonder that such patients are generally more ready to rely upon the results of their own observation and experience than upon the dictum of their physicians. Neither is it surprising that physicians often become disheartened in their attempts to prescribe therapeutic dietetics for their patients, and content themselves with the empirical employment of various palliative antidotes or ingenious methods of "toning up" or "toning down" the activities of the stomach by means of stimulants or sedatives, as the case may seem to require, leaving the patient to manage his dietary according to his own tastes or judgment.

Doubtless the late eminent Dr. Austin Flint had spent many years in baffled attempts to find the royal road of dietetics for the various classes of dyspeptics who consulted him, before he arrived at the conclusions which led him to give to his students such advice as the following, which the writer took from his lips, and which was doubtless heard during his lifetime by some of those present: "When a dyspeptic patient asks you the question, What shall I eat? reply, Eat what you like. If he asks, How much shall I eat? say to him, Eat as much as your appetite demands. If he still asks, When shall I eat? answer, Eat when you are hungry." Briefly stated, Dr. Flint's advice to a man with a disordered digestion as regards his diet was, Eat what you like, as much as you like, and when you like.

Since this has been the rule in diet with the great majority of those who seek advice for stomach disorders, it is evident that Dr. Flint did not recognize any important relation whatever between diet and disease, — a state of skepticism in which many physicians have found themselves after a similarly wide and disappointing experience in attempting to adjust the known to the unknown in making dietetic prescriptions for stomach disorders, the nature of which could only be guessed at.

Equally suggestive of the state of almost utter ignorance which has prevailed in the profession respecting the functional disorders of the stomach, is the enormous and indiscriminate consumption of pepsines, peptones, peptonoids, and digestives

and digested foods of names and forms almost too numerous to mention, which are administered and swallowed with the hope that they will do good somehow, without any clear idea as to what morbid condition is present, or how it is to be relieved by the particular agent employed.

The demand for these digestive agents has become so great that even the great beef and pork packers have gone into the business of making pepsins, beef extracts, peptones, etc., and we may expect soon to see these articles sold by the grocers along with the pork and potatoes, beef, bread, beans, etc., that they are supposed to help digest. Perhaps we shall even be able to buy our food with the proper amount of digestive agent already mixed with it, so that we shall need to take no thought for our stomachs or those of our patients, provided we have full faith in the value of the products of artificial digestion.

The great faith in pepsin, which has given rise to this enormous consumption of artificial digestive agents of various sorts, is an evidence of the almost universal lack of knowledge respecting the real nature of the chemical vital changes which constitute the process of digestion.

Mosso, several years ago, called attention to the fact that the pepsin required for the digestion of an ordinary meal is almost insignificant in amount, and that this agent is rarely ever found deficient in morbid conditions of the stomach. One of the most striking experiments made by this investigator and his colleagues, consisted in passing through the stomach of a dog, two thousand litres of water acidulated with hydrochloric acid. The digestive activity of the acid solution thus treated was found to be sufficient to digest seventy-five kilograms (165 pounds) of egg albumen. In other words, the dog's stomach is capable of furnishing pepsin enough to digest 165 pounds of meat at a single meal,— doubtless five or six times the animal's own weight.

Within recent years the important investigations respecting the chemistry of digestion, which have been carried out by various German and English physiologists, have thrown such a flood of light upon the digestive process that great hopes have been raised that more precise and exact methods might be discovered for the treatment of digestive disorders, which constitute by

far the largest share of all the ailments that come under the observation of the general practitioner.

Special interest was aroused by the recent excellent work of Ewald, whose methods of investigating functional disorders of the stomach by means of an examination of the stomach fluid, were quite generally adopted in Germany, and to some extent in England and this country. The interest at first aroused by the new methods introduced by Ewald and his collaborator, Boas, rapidly waned, however, when it was discovered that a very great and irreconcilable inconsistency existed between the results promised and those attained. Many of the methods which they proposed are most excellent, and are certainly a great improvement over methods which have previously been employed; but a single point of vital weakness in their method has rendered the practical results obtained through it most uncertain and disappointing.

Following the view of Bidder and Smith, they assume that whenever free HCl is found present in a given gastric fluid, the acidity of the fluid in question is due to HCl. They accordingly determine the digestive value of a given gastric fluid by first ascertaining the presence or absence of free HCl by means of Congo-red and methyl-violet, or other color reagents, and then determining the total acidity by the ordinary methods of acidimetry. A determination of the total acidity by acidimetry furnishes an estimate, not only of the amount of free HCl present, but of the free Cl plus that in combination. It is not true that shaking the gastric contents with ether, as proposed by the method of Ewald, will remove the organic acids present. Each acid, whether organic or mineral, has its own coefficient of solution in ether, when taken in the aqueous solution and shaken with the latter, but a very considerable amount is always left behind, certainly sufficient to constitute a most serious source of error. This mistake any one can verify for himself, by a simple experiment with an aqueous solution with lactic acid, first washing with ether as thoroughly as possible, then determining by means of a decinormal soda solution, the amount of acid present in the ethereal residue and that left behind in the acid solution.

This method is especially faulty in that it furnishes no good means of determining the amount of free HCl present, since the chlorine in combination with albumen possesses the same degree of acidifying function as does free HCl, so that with a given total acidity the chlorine present may be entirely in the form of free HCl, or may exist only in combined form. It is certainly a matter of great practical importance to know whether the chlorine in a given gastric fluid exists in a free state, or whether it is combined with albumen; and whether the relation of the combined chlorine and the free HCl is normal, or otherwise.

Hayem and Winter, of Paris, have within the last two years perfected a new method which places the chemistry of the stomach upon the same exact basis as that which has been elaborated for analysis of the urine. It is now possible, by the employment of methods perfected by these investigators, to determine the quality of a given stomach fluid with even greater accuracy than we are able to determine by chemical means the characters of a given specimen of urine. After having employed this method in the analysis of more than 400 specimens of stomach fluid, which were furnished by over 300 different patients, I consider myself in a position to speak with some degree of confidence respecting the value of this method and of the practical results to be obtained from it, and feel no hesitancy in pronouncing the method thoroughly accurate and reliable, and by all means the greatest advance which has been made in the diagnosis of disordered digestion, at least within the last half century. I translate from a work by Hayem and Winter, the following brief account of the analytical method pursued: —

"Place in three capsules, designated respectively as *a*, *b*, and *c*, 5 c. c. each of the stomach liquid previously well filtered.

"To capsule *a* add an excess of carbonate of soda; then evaporate all the capsules to dryness on the water-bath, after which proceed as follows: —

"Carry capsule *a* progressively and cautiously to a red heat, avoiding a higher temperature. To hasten destruction of the organic matters, and to diminish the action of the heat,

the dried residue should be broken and stirred frequently with a glass rod.

"The capsule should be withdrawn from the heat when the points of ignition are no longer visible, and when the mass becomes pasty by the beginning of the fusion of the carbonate of soda.

"The calcination should be just sufficient to produce a colorless solution. After cooling, add distilled water and a slight excess of pure nitric acid boiled, to drive off the excess of carbolic acid. Then neutralize the solution, or even render it slightly alkaline by the addition of pure carbonate of lime or soda. In employing carbonate of soda, the limit of alkalinity is indicated by an abundant precipitation of calcareous salts, which carry down all the carbon.

"After filtration with Berzelius's filter paper, and washing the residue with boiling water, the amount of chlorine present is determined by a decinormal solution of nitrate of silver in presence of neutral chromate of potash.

"The addition, as stated above, of a slight excess of nitric acid, favors the separation of the carbon. The final addition of the carbonate of soda in very slight excess, increases the sensibility of the indicator without interfering with the reaction.

"Proceed in the manner above described, and taking all the necessary precautions, absolutely constant results may be obtained with the same liquid. The sensitiveness of the method with the chromate of silver is great.

"The figures furnished by *a*, and expressed in HCl, represent the total amount of chlorine contained in the stomach liquid.

"(*b*.) After prolonged evaporation at 100° C., for an hour after the disappearance of all liquid, add an excess of carbonate of soda again; evaporate again, and proceed as before for the determination of the amount of chlorine present.

"The figures furnished by capsule *b* represent the total chlorine, less that which has been driven off by prolonged evaporation on the water-bath, that is to say, less the free hydrochloric acid; $a - b =$ free HCl.

"By evaporation on the water-bath at 100°, the same results are obtained as in an oven at 110°; but if the last temperature

is exceeded, even very slightly, the mass gives off white fumes, and the results are vitiated. So, for constant results, it is better to employ prolonged evaporation on the water-bath.

"(*c*.) After drying, capsule *c* is calcined with care, without the addition of soda. By breaking the residue, the calcination is hastened, and requires but a short time. Here, especially, excessive elevation of temperature must be avoided. The heat is arrested when the carbon becomes well dried and friable. The capsule should be quite deep, and only the bottom should be touched by the flame, the upper portion being protected by wire cloth. After cooling, proceed as before.

"The figures obtained from *b* represent the amount of fixed chlorides, consequently *b* — *c* will give the amount of chlorine lost during the calcination of the residue of capsule *c*, that is to say, the combined chlorine."

By comparing the results of the analyses of capsules *b* and *c*, there is found to be a difference in favor of *b*, in case the fluid examined is a product of normal digestion ; in other words, the chlorine represented by *b* is in excess of that represented by *c*, showing that chlorine exists in the gastric juice in another form than that of free hydrochloric acid, and fixed chlorides. The investigations of Richet, published a few years ago, showed that a considerable amount of chlorine exists in the gastric fluid, combined with albumen in the process of digestion. By subtracting *c* from *b*, the amount of chlorine so combined is determined.

The fluid usually employed in the chemical analysis is obtained by giving the patient a test breakfast consisting of two ounces of stale white bread and eight ounces of weak tea or hot water, without sugar or cream, and withdrawing the stomach fluid by means of a stomach tube one hour after the patient begins to eat. By this method four known quantities are obtained: —

1. The total chlorine.
2. The amount of free chlorine.
3. The amount of chlorine combined with albumen.
4. The amount of fixed chlorine.

The four quantities thus obtained — two by analysis and two by subtraction — are represented as follows : —

Total chlorine, T.

Free chlorine, H.

Chlorine combined with albumen, or organic chlorides, C.

Fixed chlorine, F.

Having determined these four quantities by chemical analysis, the total acidity, represented by A, is next determined.

A solution of Congo-red is employed as a qualitative test for the presence of free acids, and methyl-violet, Günzburg's reagent, or the resorcine and sugar test, is used to show the presence of free HCl. The color reactions are, of course, simply confirmatory of the results obtained by chemical analysis, but are of comparatively little practical value, as they give no very positive idea respecting the quantity of free acid present.

T represents the glandular work of the stomach, including also the amount of sodium chloride contained in the test meal, which must be a known and certain quantity.

H and C together (H + C) represent the chemical work of digestion, which consists of two parts : —

1. The breaking up of the chemical combination of chlorine with bases, and the production of free hydrochloric acid.

2. The combination of hydrochloric acid with albumen, the first step in the process of hydration by which the albumen is converted into peptone.

H represents the amount of free hydrochloric acid ready for combination with albumen ; C, the amount already combined.

It is evident, then, that by a comparison of the figures obtained for T, H, and C, in the case of a given stomach fluid, with the figures presented by a normal stomach fluid, we have an exact means of appreciating any modification of the normal digestive work which may be the result of morbid conditions. By a study of the results obtained upon healthy dogs and individuals, it has been shown that the quantity H (free HCl) is always small in normal digestion, as compared with C (chlorine combined with albumen or organic chlorides). It is also found that combined chlorine (C) contributes as much to the acidity of a given stomach fluid, as the same amount of chlorine would do if in the form of free hydrochloric acid (HCl).

By careful quantitative analysis, it has been shown that the total acidity (A) is chiefly due to H (free HCl) and C (com-

bined chlorine). Lactic acid and acid phosphates contribute very slightly to the total acidity of the normal conditions, hence the formula under normal conditions would be, practically, H+C=A.

From this formula may be derived the following : —

$$\frac{A-H}{C} = 1.$$

This is not absolutely true, however, as A, in small part, is made up of acid phosphates, and in the early stages of digestion also lactic acid. There are also present, even in normal cases, a small proportion of neutral or ammoniacal chloro-organic compounds, so that normally we find .86, instead of 1. This quotient is termed the coefficient of digestion, as it is a means by which a most important fact respecting the quality of the digestive process may be determined. This quantity is represented by *a*, which we may term "coefficient *a*." The practical value of coefficient *a* will be recognized by studying the following formulæ, which result from conditions to be named : —

In certain morbid states, the combinations of chlorine with albumen, or chloro-organic compounds, are, in large part, neutral instead of acid. Such compounds are the result of abnormal products of digestion, and of no use from a nutritive standpoint. These neutral substances, while contributing to the value C, contribute nothing to the value A, consequently, in a case of this sort, we should have the formula A=H+C—C′, in which C′ represents the neutral chloro-organic compounds, instead of A=H+C. Transposing H, and dividing both members of the equation by C, as before, we obtain the formula.

$$\frac{A-H}{C} = a - \frac{C'}{C},$$

in which it is evident that the coefficient *a* will be less than normal; that is, less than .86, because C is below par. The real value of C is diminished just in proportion to the amount of neutral organic compounds present. In cases of this sort, A is always small in proportion to (H + C).

It not infrequently happens, however, that A exceeds the sum of H and C; in other words, we have the formula,

A=H+C+x, in which x represents the amount which A exceeds the sum of H and C. Transposing H as before, and dividing both members of the equation by C, we have,

$$\frac{A-H}{C} = a + \frac{x}{C},$$

in which it is evident that coefficient *a* exceeds the normal quantity. These cases are those in which normal digestion is complicated by acid fermentation.

It is thus apparent that coefficient *a* serves a most useful purpose in two cases, in one of which it is less than normal, which indicates that the value of C is diminished just in proportion to the amount that *a* is diminished; in other words, that the quality of the work done by the stomach is bad, just in proportion as *a* is less than normal. On the other hand, when *a* is above normal, the indication is that acid fermentation is present, and in amount just in the proportion that *a* exceeds the normal quantity. We have here, then, a means of determining two things, which by all previous methods have been left undetermined: 1. The real quality of the work done by the stomach; 2. The proportionate amount of products of acid fermentation present.

Both these facts are of the greatest practical value. C is the index to the actual useful work done by the stomach; but C may be large, and yet the value of the work done be nothing, in consequence of the catalytic changes upon which the chemical work of the stomach depends having taken a wrong direction, so that the chloro-organic compounds formed are neutral instead of acid. This condition will be shown by coefficient *a*, without which it could not be definitely determined, although it might be suspected by the diminished value of A. On the other hand, when A is increased by acid fermentation, the fact might be taken as an indication of hyperpepsia, instead of acid dyspepsia, if reliance were placed upon the total acidity taken in connection with the presence of free hydrochloric acid, as shown by color reagents, as in the method of Ewald and Boas, and without the determination of the amount of free and combined chlorine and the value of coefficient *a*.

By long and painstaking studies of the digestive process in healthy men and dogs, Profs. Hayem and Winter have estab-

lished the following figures as representing the normal limits of variation in healthy digestion : —

	Normal variations.[1]
Total acidity (A)	(0.180 —.200 gms.)
Coefficient (a)	(.86)
Total chlorine (T)	(0.300 — 0.340 gms.)
Free HCl (H)	(0.025—0.050 gms.)
Organic chlorides (C)	(0.155—0.180 gms.) } .180–.225
Fixed chlorides (F)	(0.109 gms.)

By the use of the above exact *data*, it is possible to represent the different states of digestion. In normal digestion each of the symbols would be followed by the sign =; that is, the quantities represented by each of the symbolic letters in the formula are within the limits of normal variation as follows : —

$$A=a=T=\begin{matrix}H=\\C=\end{matrix}\Big\}=.$$

In typical hyperpepsia we have equal dominance of the sign +, as in the following formula : —

$$A+a=T+\begin{matrix}H+\\C+\end{matrix}\Big\}+.$$

Hypopepsia is characterized by the sign —, giving us the typical formula : —

$$A-a=T-\begin{matrix}H-\\C-\end{matrix}\Big\}-.$$

It is evident, however, that an almost infinite number of variations and modifications of these formulæ is possible, according as one or all of the different elements of the digestive work are exaggerated or diminished. We may have, for example, an increased amount of gland work on the part of the stomach, with diminished chemical work, in which case T would be +, and the sum of H and C —, (H + C) —.

We may also have a sufficient amount of that phase of chemical work which consists in a liberation of the chlorine from the bases, together with an abundant secretion of fixed chlorine, coincident with the failure of the chlorine to combine with albumen, in which case our formula would be —

$$T+\begin{matrix}H+\\C-\end{matrix}\Big\}=.$$

[1] Quantity of chlorine expressed as HCl in 100 c. c. of stomach fluid.

We may even have an excess of chlorine set free, and yet a very great deficiency of combined chlorine, through the failure of the chlorine to enter into normal combination with albumen. Then we should have

$$\left.\begin{matrix} H+ \\ C- \end{matrix}\right\} +;$$

or we may have H + with C —, and the sum of H and C less than normal, shown by the formula,

$$\left.\begin{matrix} H+ \\ C- \end{matrix}\right\} -.$$

It is evident that H and C, considered separately and together, represent the chemical work done by the stomach, especially when taken in connection with the quotient or coefficient *a*.

In their study of pathological cases, Profs. Hayem and Winter have employed the following method of classification : —

Considered with reference to the amount of stomach work done, pathological cases may be divided into hyperpepsia, hypopepsia, and an intermediate form, simple dyspepsia. Typical hyperpepsia is expressed by the formula already given, in which all the qualities are above normal, or +, with the exception of *a*. It is rare, however, to find a case in which there is simply an exaggeration of stomach work. There is, almost without exception, some qualitative modification of the digestive process, the recognition of which is of the highest importance. This leads to the subdivision of hyperpepsia into two classes, *quantitative* and *qualitative*, in which the characteristic deviations from the normal digestive process are, respectively, a simple exaggeration of stomach work, and a qualitative modification of the character of the work done.

Both these classes, qualitative and quantitative hyperpepsia, are again subdivided into two varieties, this division being based upon the simple difference in degree, the lesser degree being only an attenuated form of the higher degree of simple qualitative or quantitative with qualitative change. The term "attenuated" is used to designate the less pronounced variety. We thus have simple quantitative hyperpepsia, and quantitative hyperpepsia attenuated, and also hyperpepsia qualitative, and hyperpepsia qualitative attenuated.

A still further subdivision of the principal classes of hyperpepsia is based upon the presence or absence of acid fermentations; so that, in all, we have six types of hyperpepsia.

The basis for the subdivision of cases of hypopepsia chosen by Hayem and Winter is a wholly artificial one. They make three degrees of hypopepsia, in all of which we of course find A —. Cases in which A is less than normal, but above 100, are designated as hypopepsia of the first degree; those in which A is less than 100, and still a measurable quantity, are designated as of the second degree. Cases in which A is nothing are placed in a third class, apepsia.

These three classes are, with the exception of the third, each subdivided, as in the case of hyperpepsia, into two types, according as acid fermentation is present or absent. In the third class there is no acidity and hence no fermentation.

With reference to cases of hypopepsia, the value of A becomes a matter of great interest. The total acidity is not infrequently found to give a very high figure, notwithstanding the existence of hypopepsia in a very marked degree, evidently as the result of the excessive acid fermentation which is very likely to be present in this class of cases, owing to the deficiency of free hydrochloric acid, the natural antiseptic of the gastric juice. Before the classification of cases of hypopepsia can be properly made, we must determine the true value of A, that is, the amount of acidity due to the normal acid elements of the stomach fluid, the free HCl (H), and the organic chlorides or chloro-albumen compound (C).

The method of Ewald and Boas, which determines the quality of the digestive fluid by measuring the acidity and ascertaining by color reagents the absence or presence of hydrochloric acid, is thus notably defective, since it practically considers acidity to be normally due to free HCl (H). Normally, as above stated, A is composed of free HCl (H), combined HCl (C), and a small amount of lactic acid and acid phosphates. In pathological cases, however, the greater part of A may be composed of acids of the fatty series, — lactic, acetic, and butyric, — resulting from fermentation.

The determination of the presence of these acids by color reagents is a somewhat uncertain process, and sometimes en-

tirely fails, while any quantitative estimation relating to fatty acids is quite out of the question in the examination of stomach fluids, in consequence of the small amount of material usually available in an individual case.

The great advantage of the method of Hayem and Winter, and its remarkable exactness, is well shown in the ease with which it enables us to determine the true value of A. Returning to the formula,

$$\frac{A - H}{C} = a$$

we have, by multiplying both members of the equation by C, and transposition, $A = (a \times C) + H$. To ascertain the *true value of* A, which we may designate A′, in any given case, we have only to substitute in this equation the normal value of *a*, .86; then making the simple calculation indicated by the formula, we have at once the true value of A. The following case will illustrate the value of this method in the determination of the true value of A: —

In a case of very pronounced stomach disorder of long standing, the figures found for A were .313 mgs., and for *a*, 5.14. It should be remembered that the figures for A represent the acidity expressed in milligrams of HCl per 100 c.c. of the stomach fluid examined. In this same case, H was found to be .056, and C, .050, reaction for fatty acids negative. Following the method above indicated, we find the value of A′ to be 99, from which we discover at once that there is an enormous diminution of useful stomach work, although there happens to be a considerable amount of free hydrochloric acid present. The high figure of *a*, and the figures obtained for A′ show at once the cause of the hyperacidity in acid fermentation, notwithstanding the failure of the reaction for fatty acids, which we have found, as doubtless have most other physicians who have made a careful study of the chemistry of the stomach, is to a high degree unreliable.

The classification of cases of hypopepsia is necessarily in part based upon the value of A′, and not solely upon that of A. This gives rise to a sub-type of hypopepsia characterized by pseudo-hyperacidity, in which A is +, although

A′ is —. These cases are found in the fermentative types of hypopepsia.

In the careful chemical study of more than 400 cases, by the methods of Hayem and Winter, I have found a constant confirmation of their results, and a demonstration of the great advantages presented by this method over all others.

I have found, however, a number of interesting cases in which the type is decidedly different from any of those included in the classification of Hayem and Winter, which seems to require some modifications of their scheme of classification. This will appear more clearly after the study of a series of illustrative cases.

Before presenting a series of cases illustrative of the different types and varieties of stomach disorders as relates to the disturbance of the normal chemical processes of digestion, it may be well to recall briefly the significance of the different quantities which furnish the basis of classification. These quantities, represented by the symbols (A), (A′), (*a*), (T), (H), and (C), each teach an important fact in relation to digestion.

(A) represents the total acidity which is normally due almost wholly to free HCl and the combined chlorine or chloro-organic combinations present in the gastric juice, only a very small percentage of acidity being normally attributable to lactic acid and acid phosphates. In normal conditions, the total acidity is not less than .180 grams, nor more than .200 grams in 100 c. c. of stomach liquid, the acidity being represented as anhydrous HCl.

(A′). When the total acidity is greatly increased by the products of acid fermentation, it is important to know what portion of the acidity is due to normal elements, and how much must be attributed to lactic acid or to other members of the series of fatty acids. A′ is found by multiplying the quantity C by .86, the normal coefficient, and adding H, as indicated by the formula, $A' = (a \times C) + H$.

(*a*). This quantity, obtained from the formula,

$$\frac{A-H}{C} = a,$$

has for its normal value, .86. A higher figure represents the

presence of abnormal acids resulting from fermentation. A lower value shows the presence in the quantity C of neutral chloro-organic combinations having a resemblance to normal digestive products, but without nutritive value, and which contribute nothing to the acidity of the stomach fluid. Both of these facts are of great importance, especially as the information conveyed by them can be obtained in no other way. The value of a as a means of determining the quality of the chemical work done by the stomach will be readily appreciated. When below the normal figure, it indicates with certainty that the value C is depreciated by neutral chloro-organic compounds; but the amount of this depreciation is not so clearly indicated by the lowered value of a as is the amount of acid fermentation by its increased value, since the neutral compounds in C may be, to a greater or less extent, neutralized by the products of acid fermentation. Thus, while we are able to say that acid fermentation is present whenever we find a above the normal figure, we cannot with equal certainty say that acid fermentation is not present when a is less than the normal figure.

This fact is clearly shown by one or two remarkable cases, the details of which will be given later in this paper, in which the value of a is ∞, being represented by a fraction with a whole number for a numerator, and zero for a denominator,

$$\left(\frac{x}{0}\right).$$

Here x represents the amount of acidity due to the products of acid fermentation. It is evident that C might in a given case possess such a value, although wholly composed of neutral compounds, as to mask completely the value x, thus hiding the presence of the abnormal acids. The amount of acidity due to the products of fermentation which can be hidden in this way, is, however, comparatively so small that this fact does not materially lessen the value of a as an index to the quality of the chemical work done in the digestive process, and it may properly be regarded as the coefficient of digestive work. It should be remembered that a represents, not a definite quantity, but simply the proportion which exists on the one hand between the acidity normally due to the chloro-organic compounds, or

C, and the increased acidity due to the presence of the products of acid fermentation, or the diminished acidity due to the presence of neutral compounds in C. When a is found to be zero, as we have observed in a number of instances, the indication is positive both that acid fermentation is wholly absent, and that C is wholly composed of neutral and worthless compounds. a becomes ∞ when C is o, and when A exceeds H, the result obtained by subtracting H from A in this case representing exactly the amount of acidity due to acid fermentation. The significance of a when found to be ∞, is readily shown by the following formulæ: —

Recalling the formula $A = H + C + x$, in which x represents the products of acid fermentation, and the formula derived from the foregoing

$$\frac{A - H}{C} = 1 + \frac{x}{C},$$

it is clear that in any case in which $C = o$, we shall have

$$\frac{A - H}{o} = \frac{x}{o}, \text{ or } \infty.$$

In such a case A is wholly composed of the products of acid fermentation, and there is no useful work done by the stomach. Such cases might perhaps be classed as apepsia.

(T) represents the total chlorine, making allowance for the amount of chloride of sodium taken in the test-meal, and indicates the total amount of gland work done in the stomach in the secretion of fixed chlorine; that is, chlorine combined with bases.

(H) represents the amount of chlorine which has been set free under the vital influence of the stomach work, and is ready to enter into the digestive process proper, by combining with albumen.

(C) represents the amount of chlorine which, after having been set free from the bases, has entered into combination with albumen, and thus has taken part in the digestive process. When C has its proper acid value, that is, when a is $=$ or $+$, it represents the useful chemical work done by the stomach. The sum of H and C represents the total amount of chlorine set free from the bases, or what might be termed the preliminary chemical work done by the stomach.

In considering from a therapeutic point of view the results obtained by the chemical analysis of stomach fluids, it is necessary especially to keep in mind the four possible kinds of work done in the stomach : —

1. *Gland work*, represented by T.
2. *Preliminary* chemical work, represented by H + C.
3. *Useful chemical work*, represented by C taken in connection with *a*.
4. *Vicious chemical work*, or fermentation, indicated by the increased value of *a*.

Within the last six months, more than 600 analyses of stomach fluids have been made under the writer's supervision in the Sanitarium Laboratory of Hygiene, the fluids analyzed having been obtained from nearly 500 different cases. The cases studied in this paper number 321, and the number of analyses 413. A careful study has been made of the results obtained by each analysis, together with a careful comparison with the symptoms presented by the patient. It is not intended to present in this article even a brief summary of all the interesting facts which have been noted, but merely to give a sufficient number of cases to illustrate each one of the leading forms of disturbance in the digestive process which have been observed.

Before presenting these illustrative cases, it must be stated that the study of this large number of cases has brought to light a considerable number of forms which were not noted by Hayem and Winter in their investigation, which involved only 200 analyses, and a considerably smaller number of cases. As the work progressed, the increasing number of new forms finally became so great as to compel me to undertake a new classification, the necessity for which has become more and more apparent by the constant discovery of a marked difference as regards therapeutic requirements existing between cases grouped by Hayem and Winter in the same class. The classification herewith presented is certainly not above criticism, and whether or not it is any improvement upon classifications previously presented, will appear only after it has been subjected to the ordeal of examination by those compe-

tent to estimate its value, and the test of a longer experience. It is offered simply as the best attempt the writer can make at the present time toward grouping the various forms of disturbance in the chemical processes of the stomach in such a manner as to show at a glance both the therapeutic indications and the relation of each individual form to dissimilar or cognate forms.

The classification offered ought not perhaps to be termed an entirely new one, as it recognizes many of the same principles as that made by Hayem and Winter.

As in the classification of Hayem and Winter, the term *hyperpepsia* is used to indicate an excess of stomach work, and *hypopepsia*, a deficiency of stomach work; *hyperhydrochlorie*, an excess of free HCl (H +), and *hypohydrochlorie*, a deficiency of free HCl (H —) I have used the term *hyperclorhydrie* to indicate an excess of combined chlorine (C +), and *hypochlorhydrie*, a deficiency of combined chlorine (C—). The terms *hyperacidity* and *hypoacidity* are self-explanatory. The principles upon which the classification is based are as follows: —

Three great classes are recognized,—

I. *Hyperpepsia*, in which an excessive amount of both glandular work and chemical work are done.

II. *Hypopepsia*, in which there is a notable diminution in the stomach work; if not always in the glandular work, in the chemical work.

III. *Simple dyspepsia.*

Each of these classes is again subdivided.

Hyperpepsia is divided into three groups, the characteristics of which are,—

(a.) H +, free hydrochloric acid in excess. Hyperpepsia with hyperhydrochlorie.

(b.) H —, free hydrochloric acid deficient. Hyperpepsia with hypohydrochlorie.

(c.) C —, a deficiency of combined chlorine or of useful chemical work. Hyperpepsia with hypochlorhydrie.

We always find C+ in groups (a) and (b), and H+ in group (c).

Groups (a), (b), and (c) are each divided into sub-groups, in which we find, respectively, A +, and A —, or hyperacidity and hypoacidity.

We have a still further division of sub-groups into two types, as acid fermentation is present or absent, as indicated by coefficient *a*.

In group (c), characterized by hypochlorhydrie (C —), or a failure of the free HCl to combine with the albumen, forming thus an organic chlorhydrate, we have three sub-groups characterized respectively by (1), hyperacidity; (2), hypoacidity; and (3), pseudo-hyperacidity (A + A′ —). (1) and (2) have each two types, with and without fermentation, (3) of course presenting but one type, fermentation being always present.

Group (c) presents also a fifth sub-group, in which the amount of acid fermentation is so great that A + A′ — is found.

Hypopepsia.— The basis chosen by Hayem and Winter for the classification of hypopepsia is followed, three classes being formed, in the first of which A or A′ is less than normal but above .100, and in the second, below .100; in the third, or apepsia, A is 0. A′ is necessarily always —, in hypopepsia. In each of the first and second degrees of hypopepsia, we have two sub-groups, A— and A+, or hypoacidity and hyperacidity. A— presents two types, as acid fermentation is absent or present. A+ presents, necessarily, but one type, that of acid fermentation. This type is conveniently termed *pseudo-hyperacidity*, as the total acidity may be high, although the value of A due to the normal elements of gastric juice, or A′, may be small. As above indicated, I have found cases of pseudo-hyperacidity in hypopepsia of the second degree (a number of cases), although Hayem and Winter in their smaller number of cases observed this type only in hypopepsia of the first degree.

Simple Dyspepsia.— I have divided simple dyspepsia into two classes: —

(a.) Cases in which acid fermentation is absent.

(b.) Cases in which acid fermentation is present.

Each of these groups is divided into two sub-groups. The basis taken for the subdivision of group (a) is the value of coefficient *a*, which may be (1) =, or (2)—. In group (b) the basis of subdivision is the value of C, which is (1) +, and (2) —.

The utility of this classification from a therapeutical standpoint will be seen when we consider the therapeutic indications of each of the several classes, sub-classes, and types recog-

CLASSIFIED REPRESENTATION OF THE VARIOUS DISORDERS OF THE CHEMICO-VITAL PROCESSES OF DIGESTION.*

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HYPERPEPSIA	Hyperhydrochlorie (H+) (Free HCl in excess)	Hyperacidity (A+)	—a. f.	A+	*a*—;=	T+;=	H+ C+	+
			+a. f.	A+	*a*+	T+	H+ C+	+
		Hypoacidity (A—)	—a. f.	A—	*a*—	T+;=	H+ C+	+
	Hypohydrochlorie (H—) (Free HCl deficient)	Hyperacidity (A+)	—a. f.	A+	*a*—;=	T=;+;—	H— C+	+
			+a. f.	A+	*a*+	T+;=;—	H— C+	+
		Hypoacidity (A—)	—a. f.	A—	*a*—	T=;+	H— C+	+;=
	Hypochlorhydrie (C—) (Combined Cl deficient)	Hyperacidity (A+)	—a. f.	A+	*a*—	T+	H+ C—	+
			+a. f.	A+	*a*+	T+;=	H+ C—	=;+
		Hypoacidity (A—)	—a. f.	A—	*a*—	T+;=;—	H+ C—	—;=;+
			+a. f.	A—	*a*+	T+;—	H+ C—	—;=;+
		Pseudo-hyperacidity (A+A'—)	+a. f.	A+	*a*+	T+;—	H+ C—	=;—
HYPOPEPSIA A'—	1ST DEGREE A or A'—, but above .100 gms.	Hypoacidity (A—)	—a. f.	A—	*a*—	T—;=;+	H—; 0;= C—;+;=	—;=
			+a. f.	A—	*a*+	T—;=;+	H—;=; 0 C—;=;+	—;=
		Pseudo-hyperacidity (A+A'—)	+a. f.	A'—	*a*+	T—;+;=	H—;= C—;=;+	—;=
	2ND DEGREE A or A'—, and below .100 gms.	Hypoacidity (A—)	—a. f.	A—	*a*—; 0	T—;=;+	H—; 0;= C—; 0	—
			+a. f.	A—	*a*+	T—;=;+	H—;=; 0 C—; 0	—
		Pseudo-hyperacidity (A+A'—)	+a. f.	A'—	*a*+	T—;=	H=;— C—	—
	3RD DEGREE A=0—Apepsia			A 0	*a* 0	T—	H 0 C—	—
SIMPLE DYSPEPSIA	Without acid fermentation	Typical (*a*=)		A=;+	*a*=	T=;+;—	H=;—;+ C+;	+;=
		Qualitative (*a*—)		A—;=;+	*a*—	T=;—;+	H=;— C+;=	=;+;—
	With acid fermentation	Hyperchlorhydrie (C+)		A=;+;—	*a*+	T=;—;+	H=;— C+	=;+
		Hypochlorhydrie (C—)		A—	*a*+	T=	H= C—	=

* The signs and symbols employed in this classification relate to the following quantities determined by the study of the digestive process in healthy subjects to be the limits of normal variation, the quantity of chlorine being expressed as HCl, and the values given having relation to 100 c.c. of stomach fluid :—

Total Acidity (A or A') .180–.200 gms.
Total Chlorine (T) .300–.340 gms.
Combined Chlorine (C) .155–.180 gms.
Coefficient (*a*) .86.
Free HCl (H) .025–.050 gms.
Fixed Chlorine (F) .109 gms.
Total Chlorine set free from bases (H+C) .180–.225 gms.

nized in this class of cases. How these therapeutic indications are to be met is a subject too large for consideration in this paper, but one which I have made the subject of long and varied experimentation, extending through several years, the results of which I shall report in another paper. The limits of this paper will admit of no more extended reference to this branch of the subject than a few brief suggestions.

In the accompanying outline exhibiting the classification which I have briefly described, —a.f. means without acid fermentation ; + a.f., with acid fermentation.

A great advantage offered by this classification is the fact that it affords a basis for a new and simple nomenclature of functional disorders of the stomach due to disturbance of the chemico-vital processes of digestion. The twenty-two groups which I have formed, include all of the different forms of deranged chemical processes which I have encountered in the 413 analyses upon the study of which this paper is based —a number sufficiently large, I think, to include practically all the different forms likely to be met with in practice.

Another very great advantage presented by the classification and nomenclature proposed is found in the fact that the name of each morbid condition not only clearly identifies it by exhibiting its characteristic features, but gives at the same time its therapeutic indications. It is also so simple and natural that it can be mastered with very little study. It is only necessary to keep in mind the following points to be able to classify at sight any case after obtaining the necessary data by analysis, and representing it in a formula : —

1. Whenever H + is found, the case is one of hyperpepsia, unless we find also (H + C) =, when it may be a case of simple dyspepsia, which will be determined by noting if all the quantities are within the normal limits, or closely approach them.

2. Hyperpepsia also exists in some cases in which we find H — and C + and (H + C) +. We may have (H + C) = with H — and C + in both hypopepsia and hyperpepsia ; but if the case is one of hypopepsia, T will be — or = ; if it is hyperpepsia, +.

3. Having settled the question as to whether the case is one of hyperpepsia or hypopepsia, simply write down the word

"Hyperpepsia" if the case belongs to this class, then note the signs opposite H and C. If both are +, then write next to the word "Hyperpepsia" the word "Hyperhydrochlorie." If H is —, write, instead, "Hypohydrochlorie;" or if H is + with C —, write "Hypochlorhydrie." Next note the sign opposite A; if +, add to the two preceding words the word "Hyperacidity." If A is within the normal limits, this term may be omitted; or if the figures approach close to the upper limit, "Hyperacidity" may be written, and if the figures nearly correspond with the lower limit of the normal range, "Hypoacidity" may be written. One more point must be noted: Whether or not acid fermentation is present, which will be determined by coefficient *a*. If *a* + is found, acid fermentation is certainly present; if *a* —, fermentation is presumably absent. The presence or absence of acid fermentation may be indicated by writing after the preceding terms — a. f. or + a. f. as the case may be. Thus, the name of the first form noted in my scheme of classification would be *hyperpepsia* with *hyperhydrochlorie* and *hyperacidity*, without *acid fermentation*.

The naming of cases of hypopepsia is simpler, as there are fewer subdivisions. The same principles are followed as with hyperpepsia. The same may be said, also, with reference to simple dyspepsia. By the aid of the accompanying scheme of classification, any one can classify any case of disturbed chemical action in the digestive process after obtaining the necessary analytical data, with a very little practice, and even without going as deeply into this subject as is desirable and really necessary for a full grasp of it.

I find it convenient in making notes of cases to abbreviate the terms employed, as follows: Hyperpepsia, *Hprp.*; Hypopepsia, *Hpop.*; Hyperhydrochlorie, *Hprhcl.*; Hypohydrochlorie, *Hpohcl.*; Hypochlorhydrie, *Hpoclh.*; Hyperacidity, *Hprac.*; Hypoacidity, *Hpoac.*; Pseudo-hyperacidity, *Pshprac.*; Acid fermentation, *a. f.* Thus the form above referred to might be briefly written Hprp-Hprhcl-Hprac — a. f.

The ingenious method of representing stomach disorders by means of formulæ, originated with Hayem and Winter, the authors of the methods of analysis upon which this method of studying stomach disorders is based.

CASE 64.

Normal Digestion.— A lady aged 35 years had been for a few weeks under treatment for pelvic and nervous disorders, which required an application of the rest-cure. She had been recently allowed to take exercise, and was gaining rapidly in flesh and strength; tongue clean, and no symptoms of disordered digestion. The following were the quantities found: (A), .175; (*a*), .85; (T), .322; (H), .042; (C), .156; giving the formula,

$$A = a = T = \begin{matrix} H = \\ C = \end{matrix} \Big\} =.$$

In this case, the chemical processes concerned in digestion are evidently entirely normal.

Hyperpepsia. — The following cases illustrate the different forms of hyperpepsia: —

Hyperpepsia with hyperhydrochlorie and hyperacidity — without acid fermentation.

CASE 39.

The patient, a lady aged 49 years, had suffered for many years from disorders which had been greatly aggravated by the frequent use of purgatives for the relief of obstinate constipation. The symptoms relating to the stomach were, eructations of gas, extreme acidity, frequent attacks of severe pain in the stomach, good appetite, heaviness at the stomach. Many neurasthenic symptoms were also present, including great mental depression, sleeplessness and vertigo, urine scanty, with sediment of urates and uric acid. Physical examination showed the stomach to be moderately dilated, great tenderness in both lumbar ganglia of the sympathetic, abdominal muscles very tense. The quantities given by analysis were as follows: (A), .256; (*a*), .07; (T), .560; (H), .240; (C), .224.

Formula: $$A + a - T + \begin{matrix} H + \\ C + \end{matrix} \Big\} +.$$

Hyperpepsia with a great excess of free hydrochloric acid, without acid fermentation. The eructations of gas and other symptoms in this case would have led to the conclusion that the patient was suffering from simple acid dyspepsia, and might perhaps have suggested the employment of hydrochloric

acid as a means of suppressing abnormal fermentations, or remedies of a stimulating character to induce a greater degree of digestive activity. The gas was evidently the result, not of fermentation, but of the secretion of CO_2 from the blood, which not uncommonly occurs in cases of excessive irritability and consequent congestion of the gastric mucous membrane. On the employment of means for suppressing the excessive amount of glandular activity shown by the high figure of T, the patient rapidly improved, and in a few weeks left the Sanitarium with every evidence of permanent improvement of health.

Hyperpepsia with hyperhydrochlorie and hyperacidity — acid fermentation.

CASE 226.

A young man aged 22 years, who had been addicted to hasty eating, overeating, excessive use of sweets, confectionary, meats, drinking freely of fluids at meals, and of sedentary habits, had employed for relief, but without benefit, various mineral acids, hot water drinking, etc. He complained constantly of too abundant secretion in the mouth, burning in the œsophagus, fullness, distension of the stomach, eructations of great quantities of gas, regurgitation of hot, sour liquid, frequent attacks of sharp pain in the stomach soon after eating, excessive appetite, inability to digest coarse foods, such as cabbage, green peas, etc.; burning and heaviness at the stomach; extreme constipation, bowels moving not more often than once in three days; stools hard; gaseous distension of the bowels; poor memory; inability to concentrate the mind; dullness; hesitancy in speaking; drowsiness after meals; headache; heaviness in the head; strained feeling in the eyes; pain in the scalp and chest; coldness of extremities, especially of the knees; feverishness fifteen or twenty minutes after eating; specks before the eyes; occasional loss of sight; general feeling of weariness and exhaustion; shortness of breath. Physical examination showed a considerable degree of dilatation of the stomach. The quantity of stomach fluid removed was 125 c. c., reddish in color, and presented a considerable quantity of mucus. The quantities obtained were as follows: (A), .352; (*a*), .95; (T), .428; (H), .140; (C), .224.

Congo-red and methyl-violet gave strong reactions. Uffelmann's reagent showed lactic acid present in considerable amount. Biuret reaction showed peptones present in moderate amount. Lugol's solution gave blue violet color, indicating but slight digestion of starch. The chemical work done by the stomach in this case is represented by the following formula :

$$A + a + T + \begin{matrix} H + \\ C + \end{matrix} \Big\} + .$$

CASE 73.

A young woman of twenty-four years, had suffered for many years from stomach disorders, without finding relief, although a great variety of medical means were employed. The following quantities were obtained: (A,) .380; (*a*), 1.35; (T), .440; (H), .070; (C), .230.

Formula :

$$A + a + T + \begin{matrix} H + \\ C + \end{matrix} \Big\} + .$$

Uffelmann's reagent showed in this case a great amount of lactic acid, and the stomach fluid when withdrawn exhibited a dark brown color, probably due to the presence of a small quantity of blood, the result of the intense congestion of the mucous membrane present in the case. The hyperacidity in this case was certainly very remarkable, and the highest I have yet encountered, being nearly double the maximum amount presented in health. The determination of the value of A in this case, showed that the acidity due to the products of acid fermentation was equivalent to nearly .100 grams of anhydrous HCl for each 100 c.c. of the stomach fluid.

Hyperpepsia with hyperhydrochlorie and hypoacidity — without acid fermentation.

CASE 51.

The patient, a lady aged 37 years, had suffered for many years from a variety of stomach symptoms, which had recently led to a diagnosis of malignant disease. She had been assured that she was suffering from cancer involving the stomach, liver, and spleen, and that her case was hopeless. The patient suffered from constant pain in the stomach, flatulency, throbbing at the epigastrium, pain in the head, general nervousness, depression,

emaciation, and obstinate constipation. Physical examination showed extreme sensitiveness of the solar plexus and of both lumbar ganglia; the lower border of the stomach was three inches below the umbilicus, the right kidney was prolapsed, the bowels prolapsed, the abdominal walls extremely flaccid. The figures furnished by analysis of the stomach fluid were as follows: (A), .132; (*a*), .38; (T), .364; (H), .048; (C), .224.

Congo-red and methyl-violet both gave good reactions, and the biuret reaction indicated the presence of albuminoids. The formula representing the digestive work in this case is

$$A - a - T + \left.\begin{matrix} H = \\ C + \end{matrix}\right\} +.$$

The figures for (H) are so near the maximum in this case, that it is evidently proper to class it with cases in which (H) is +, the case being, in all other respects, identical with those which fall in this group.

Hyperpepsia with hyperhydrochlorie and hypoacidity — with acid fermentation.

CASE 207.

The formula for a typical case of this form of dyspepsia would be,

$$A - a + T + \left.\begin{matrix} H + \\ C + \end{matrix}\right\} +.$$

I have not yet met a typical case of this form, but have found cases so nearly approaching it that I expect to meet it in the study of a larger number of cases. It is only necessary that the value of C should be so small that with the addition of the products of acid fermentation present in the case, the total acidity is still below the normal figure, a condition which is certainly not unlikely to occur.

Hyperpepsia with hypohydrochlorie and hyperacidity — without acid fermentation.

CASE 197.

A lady, aged 30 years, had long suffered from severe headache, although she had experienced no special symptoms which she had herself attributed to the stomach. She confessed to careless habits of eating, eating hastily and sometimes

to excess, especially in the use of flesh meats and salads, of which she was very fond. The patient was also subject to attacks of shortness of breath and impairment of vision. Physical examination showed foul tongue, great tenderness of both the right and the left ganglia and of the abdominal sympathetic. Examination of the stomach fluid gave the following results: (A), .204; (*a*), .76; (T), .332; (H), .000; (C), .268.

Congo-red gave a good reaction; methyl-violet, none. Uffelmann's reagent showed lactic acid present, and the biuret reaction indicated the presence of peptones in moderate amount. The above figures furnish the following formula:

$$A + a - T = \begin{matrix} Ho \\ C + \end{matrix} \Big\} +.$$

In this case it will be noted that peptones were formed, notwithstanding no free hydrochloric acid whatever was present in the gastric juice. An abundance of hydrochloric acid was secreted, as shown by the high figure of T, and more than the usual amount of useful stomach work was done, as shown by the high figure of C. The diminished value of coefficient *a*, however, indicates the presence of an abnormally large amount of neutral compounds in C, probably a larger amount even than is indicated by the lessened value of coefficient *a*, since lactic acid was shown to be present, indicating a considerable degree of acid fermentation concealed. When C is in excess, its quality is usually diminished, a very striking example of which we have already given in case 39, in which the value of coefficient *a* was only .07.

Case 246.

The patient, aged 43 years, had suffered for many years from stomach disorders as the result of hasty eating, overeating, irregular meals, excessive use of sweets, fats, meats, fluids at meals, pickles, vinegar, and tea and coffee. Bad positions in sitting, sedentary habits, and the traction of heavy skirts upon tight waistbands had aggravated her disorders. Quinine, mineral waters, and a variety of laxatives and tonics had been tried without relief. The patient observed a metallic taste in the mouth in the morning, which sometimes remained during the entire day; a very bad breath; eructations of gas;

fullness in the stomach; nausea, lasting from 15 to 20 minutes; appetite variable; special craving for coffee, pastry, and rich food; bowels constipated; prolapse of rectum; extremely nervous and depressed; occasionally giddy; constant sense of weariness; palpitation of the heart. Physical examination showed a brown coat upon the tongue, and extreme tenderness of the sub-umbilical ganglion. Examination of the stomach fluid after the usual test meal consisting of 1½ ounces of dry unfermented bread with 8 ounces of water, gave the following figures: (A), .200; (*a*), .71; (T), .376; (H), .008; (C), .272.

Congo-red and methyl-violet both gave good reactions. Reaction for lactic acid was pronounced, as also the biuret reaction. Lugol's solution showed that starch digestion had advanced only to the state of erythro-dextrine, as indicated by the light purple color; rennet ferment abundant. The above figures give the following formula:

$$A = a - T + \begin{matrix} H - \\ C + \end{matrix} \Big\} +.$$

The acidity in this case is at the extreme upper limit of normal variation, and hence the case may be fairly classed as one of hyperpepsia with hypohydrochlorie, without acid fermentation. The following is another very interesting case of the same sort: —

CASE 236.

The patient, aged 45 years, had not considered herself dyspeptic, and until recently had enjoyed excellent health. Weighed, eighteen months previously, 192 pounds; present weight, 108 pounds; had been accustomed to use meat, sweets, and coarse vegetables freely, but made little use of fruits; condiments, tea, and coffee had also been freely used. The only symptoms relating directly to the stomach, which the patient had noted, were, occasional vomiting when constipated, and burning at the stomach much of the time; frequent attacks of diarrhœa; pain in the right side; ringing in the ears; scanty urine. Physical examination showed stomach and bowels prolapsed, right and left ganglia of the sympathetic sensitive, abdominal walls extremely flaccid. Examination of the stomach

fluid gave the following figures: (A), .196; (*a*), .80; (T), .324; (H), .004; (C), .240.

Methyl-violet gave a slight reaction for free HCl. Uffelmann's reagent indicated the presence of lactic acid. Biuret reaction showed abundance of peptones; Lugol's solution showed imperfect digestion of starch. The formula furnished by the above figures, is

$$A = a - T = \begin{matrix} H - \\ C + \end{matrix} \Big\} +.$$

A case of hyperpepsia with a deficient amount of free hydrochloric acid, or hypohydrochlorie, and without acid fermentation.

Many cases of this sort are met, and show clearly that the presence of free HCl is not a matter of so great importance as has formerly been supposed. The diminished value of (*a*) in this case, accounts in part, perhaps, for the steady loss of flesh observed in this patient during a series of months. The patient made a rapid gain in flesh after being put to bed and subjected to the treatment indicated for relief of her stomach disorder.

Hyperpepsia with hypohydrochlorie and hyperacidity — acid fermentation.

CASE 254.

The patient, a young woman aged 22 years, had for two or three years been running down in health, suffering from a variety of nervous symptoms which had been attributed to excessive work in school, and other causes which probably had little or nothing to do with her condition. The patient was considerably emaciated, very weak, and extremely nervous. Physical examination showed a foul tongue; stomach dilated, the lower border of the stomach being an inch below the umbilicus; the abdominal walls much relaxed; considerable degree of ovarian irritability, which, however, probably had little to do with the general condition. The amount of fluid withdrawn from the stomach was 60 c. c., and examination gave the following results: (A), .280; (*a*), 1.03; (T), .312; (H), .004; (C), .268.

The color reagents showed the presence of free hydrochloric acid in abundance, also lactic acid. The biuret reaction showed peptones abundant. Lugol's solution gave a purple

reaction, indicating imperfect starch digestion. Rennet ferment abundant. The formula resulting from the above is as follows:

$$A+a+T=\begin{matrix}H-\\C+\end{matrix}\Big\}+.$$

The young woman made rapid improvement under measures directed to the relief of her stomach disorder.

Hyperpepsia with hypohydrochlorie and hypoacidity — without acid fermentation.

CASE 151.

The patient, a lady aged 45, had long suffered from digestive disturbance as the result of irregular eating, the use of pickles, cheese, and other harmful articles of food, waist constriction from corsets and waist bands, and the use of coffee. Appetite diminished, stools very irregular, alternation of constipation and diarrhœa, gaseous distension of the bowels, tenesmus of lower bowel, general nervous exhaustion, constricted feeling in the region of the heart, tongue flabby, hyperæsthesia of the lumbar ganglia of the sympathetic. At the time of examination there was impaction of the lower bowel. The amount of fluid was 74 c. c. A .160, *a* .73, T .304, H .008, C .206. Congo-red and methyl-violet both gave slight reaction. Lactic acid test negative, peptones abundant. Formula:

$$A—a—T=\begin{matrix}H-\\C+\end{matrix}\Big\}+.$$

Hyperpepsia with hypohydrochlorie and hypoacidity — with acid fermentation.

To complete the scheme of classification, I ought to be able to present here a case of hyperpepsia with hypohydrochlorie and hypoacidity — with acid fermentation. Such a case would require the following formula:

$$A—a+T+;=;-\begin{matrix}H-\\C+\end{matrix}\Big\}+;=.$$

As will be seen by reference to the chart, this formula might occur also in hypopepsia of the first degree, with hypoacidity and acid fermentation, the only thing required being a slightly higher value for T and for C than I have happened to meet in any of the cases thus far studied; so this may be considered

as the point at which hyperpepsia and hypopepsia meet and overlap.

Hyperpepsia with hypochlorhydrie (C—) *and hyperacidity* (A+) *— without acid fermentation*

CASE 129.

A young woman aged 22 years, had been accustomed to take great quantities of fluids at meals, and had taken large quantities of iron, which she thought to be in part the cause of her condition; suffered from regurgitations of food, especially at menstrual periods; had excessive appetite and a craving for acid foods; extremely nervous; impaired memory; loss of energy; mental confusion; inability to concentrate the mind; occipital and frontal headache; general pain; distress and giddiness; disturbance of vision; specks before the eyes; appearance of fire before the eyes; general exhaustion; trembling of the limbs. Physical examination showed tongue coated white over its whole surface; the lower border of the stomach one inch below the umbilicus; solar plexus extremely sensitive; abdominal walls flaccid. The amount of stomach fluid withdrawn was 170 c.c., more than four times the normal amount. The following is the result of the examination of the stomach fluid: (A), .256; (*a*), .80; (T), .360; (H), .152; (C), .130. Peptones abundant. Formula:

$$A + a - T + \begin{matrix} H + \\ C - \end{matrix} + .$$

A case of hyperpepsia with diminished amount of useful chemical work, as shown by C —, and hyperacidity from the excessive quantity of hydrochloric acid present, but without acid fermentation.

Hyperpepsia with hypochlorhydrie (C—) *and hyperacidity* (A+) *— with acid fermentation.*

CASE 199.

Young woman of 28 years, who had suffered from stomach disorders for a number of years, the most prominent symptoms being acid and flatulent dyspepsia; heaviness of the stomach; general weariness and confusion of thought. Quantity of fluid

withdrawn, 150 c. c. Result of examination of stomach fluid: (A), .280; A', .252; (*a*), 1.14; (T), .394; (H), .166; (C), .100.

Formula derived from the above quantities:

$$A + a + T + \begin{matrix} H + \\ C - \end{matrix} \Big\} +.$$

This case is nearly identical with the preceding, only differing from the fact that acid fermentation was present.

It is important to obtain the value of A' in these cases, so as to be able to form a correct judgment respecting the amount of actual stomach work done, as the value of A in cases of acid fermentation is always more or less due to the acid products of fermentation. By comparison of the values A' and A, one can form at once an estimate of the amount of normal chemical work done by the stomach as compared with the abnormal chemical work in the form of acid fermentation.

Hyperpepsia with hypochlorhydrie (C—) and hypoacidity (A—) — without acid fermentation.

CASE 59.

A man of 57 years, who had for many years been accustomed to high living and the free use of ardent spirits. Examination of the stomach showed marked dilatation. A chemical analysis gave the following figures: (A), .088; (*a*). 0; (T), .360; (H), .090; (C), .090.

Biuret reaction very slight, indicating the absence of neither peptones nor albuminoids. Formula:

$$A - a - T + \begin{matrix} H + \\ C - \end{matrix} \Big\} =.$$

A case of marked hyperpepsia, as indicated by the high figure for free hydrochloric acid, yet with pronounced hypoacidity, and without acid fermentation. The zero value of coefficient *a* indicates the total absence of useful work on the part of the stomach.

Hyperpepsia with hypochlorhydrie (C—) and hypoacidity (A—), with acid fermentation.

CASE 100.

Patient, a man aged 26 years. Had suffered for a number of years with digestive disorders, the principal symptoms of which

were eructations of gas, heart-burn, headache, constipation. Patient had been addicted to the use of tobacco and alcoholic drinks, and had taken a great deal of medicine of various sorts without relief. Hyperæsthesia of the solar plexus and right lumbar ganglia of the sympathetic. Patient had suffered from various nervous disorders and sexual weakness.

The amount of fluid withdrawn from the stomach after the test meal, was 120 c. c. The result of the analysis was: (A) 172; (A′) 142; (*a*) 1.21; (T) .364; (H) .068; (C) .086.

Formula:

$$A—a+T+\begin{matrix}H+\\C—\end{matrix}\Big\}\sim$$

Biuret gave violet reaction, which showed the absence of peptones and the presence of albuminoids. Much mucus and considerable residue. The high figures for T indicated in this case the abundant secretion of fixed chlorine, but failure of the stomach to set free the proper amount of chlorine. The high figures for H show an excessive amount of free chlorine, notwithstanding the small value of C, which is due to the failure of the chlorine to combine with the albumen.

Hyperpepsia with hypochlorhydria (C—) *and pseudo-hyperacidity* (A+A′—) — *with acid fermentation.*

CASE 243.

A young man, a clergyman, aged 32 years, had for many years suffered from disorders of the stomach, giving rise to headache, emaciation, languor, and diminished mental and physical activity. The most prominent stomach symptoms were morbid thirst, irritation of the throat, coughing, burning at stomach, constant eructations of gas, daily attacks of pain coming on after meals, pain variable in character, described as gnawing, dull, and sharp, no appetite until after beginning the meal, appetite increasing with the meal. Patient unable to eat potatoes and other vegetables and raw apples. Sensation of ball in the stomach, coldness and throbbing in the stomach. Bowels regular, stools very fetid and of a light yellow color. Gaseous distension of the bowels. Nervousness. Mental dullness. Fidgets. Drowsiness after meals. Frontal headaches and disposition to support the back of the head. Pain in the scalp, stomach, and under the shoulder blades. Giddi-

ness. Frightful dreams, sudden waking with fright. Coldness of extremities and between the shoulders. Burning sensation after eating, with flushing of face, occurring ten or fifteen minutes after eating. Exhaustion and weariness in the morning, and involuntary sighing. Tongue foul, especially at its back part.

Examination of stomach showed it to be considerably dilated, its lower border being below the umbilicus. Quantity of fluid withdrawn after a test meal, 245 c. c. Color green, no mucus. Analysis gave the following: (A) .236; (A′) .158; (*a*) 1.64; (T) .260: (H) .072; (C) .100. Reaction for lactic acid negative; peptone reaction good; rennet ferment absent, rennet zymogen abundant; starch digestion very complete as shown by the brown color with Lugol's solution. Formula:

$$A+A'—a+T—\begin{matrix} H+ \\ C— \end{matrix}\Big\}—$$

In such a case as the above the importance of determining the value of (A′) is very evident since it gives at once an estimate of the amount of acidity which is due to acid fermentation, and which can be very promptly suppressed by the employment of proper measures to render the stomach aseptic. In this case the acidity due to acid fermentation was found to be equivalent to .078 gms. of anhydrous HCl for each 100 c. c. of the stomach fluid.

Studied by means of Ewald's method, or, indeed, by any other than the precise method presented in this paper, an entirely wrong conception would have been formed concerning the character of this case, since the failure of the color reactions for lactic acid, and the absence of acetic acid, left no means of detecting the presence of acid fermentation or of estimating the amount of abnormal acids formed. But the determination of the value of (A′) by the method previously described, gives us an exact measure of the amount of acid fermentation products present, and thus of the extent to which acid fermentation occurs. Studied by other methods, this case would be regarded as a very pronounced case of hyperpepsia without acid fermentation, although it is clear from consideration of the value of (A′), of (T) and of (H+C), all of which are considerably below normal, that there is really a diminution of

normal stomach work in all its branches; although the large amount of free hydrochloric acid present, nearly double the average amount, characterizes the case as one of hyperpepsia. From a therapeutic standpoint, however, this group of cases of hyperpepsia must be treated very differently from the typical forms of hyperpepsia, and hence its detection is a matter of very great importance.

The cause of the fermentation in this case is clearly indicated by the great quantity of fluid found, which was equal to the total quantity taken at the test meal, and more than six times the normal amount. It may be supposed from the large amount of fluid withdrawn from the stomach, considered in connection with other symptoms presented by the case, that this patient's stomach was seldom, if ever, empty, a fluid remnant remaining over from each meal to infect the next, thus keeping up a state of constant fermentation.

CASE 155.

The patient, aged 25 years. The stomach fluid when withdrawn was green in color, indicating the presence of bile. Result of analysis: (A), .192; (A'), .152; (*a*), 2.29; (T), .404; (H), .128; (C), .028.

Formula derived from the above quantities:

$$A' - a + T + \left.\begin{matrix} H+ \\ C- \end{matrix}\right\} -.$$

A case of hyperpepsia with hypoacidity, and with deficiency of useful stomach work, and acid fermentation.

In this case as in the preceding it was necessary to obtain the value of A' in order to form a correct estimate of the amount of normal chemical work done by the stomach, since the acid fermentation present contributes more or less to the value of A. In the present case, A is normal, although A' is much below the normal value, and this notwithstanding the high value of H.

Hypopepsia of the first degree (*A'— but above .100*) *with pseudo-hyperacidity* (A+) *due to acid fermentation.*

CASE 154.

The patient, aged 37 years, had suffered from stomach disorders for some time; had been addicted to the free use of tea

and coffee and usual errors in diet. The stomach symptoms noted, were, distress two or three hours after eating; eructations of gas; sometimes regurgitation of food with small clots of blood; vomited black clots of blood one month previous; burning pain; appetite variable; bowels very inactive; insomnia; general exhaustion; palpitation of the heart. Physical examination showed red tongue coated in the center; lower border of stomach below the umbilicus; great tenderness of the solar plexus and the umbilical ganglia; general tenderness of the abdomen. Stomach tube withdrew 120 c. c. of fluid. Analysis gave the following figures: (A), .320; (A′), .140; (*a*). 2.14; (T), .392; (H), .020; (C), .140.

Peptone reaction slight. Formula:

$$A + (A^{1} —)\, a + T + \left.\begin{matrix} H — \\ C — \end{matrix}\right\} —.$$

Hypopepsia of the first degree with hypoacidity — without acid fermentation.

Case 275.

A young woman, 25 years of age, had suffered from dyspepsia and a variety of general nervous and pelvic symptoms for a number of years. Stomach tube withdrew 70 c.c. of fluid. Result of examination: (A), .124; (*a*), .73; (T), .288; (H), .016; (C), .148.

Peptones and rennet ferment abundant. Lugol's solution gave the purple reaction of erythro-dextrine. Formula:

$$A — a — T — \left.\begin{matrix} H — \\ C — \end{matrix}\right\} —.$$

A case of hypopepsia of the first degree, with hypoacidity and without acid fermentation.

Hypopepsia of the first degree with hypoacidity — with acid fermentation.

Case 117.

The patient, an unmarried lady aged 33, had suffered for a number of years with stomach disorder, the prominent symptoms of which were nausea in the morning, constipation, constant occipital headache, sensation of pressure and heaviness in the head, and muscular twitching. The lower border of the stomach was two inches below the umbilicus. The right kidney was

movable, hyperæsthesia of the right lumbar ganglion of the sympathetic. The quantities obtained by analysis were as follows: Amount of stomach fluid 300 c. c.; slight amount of mucus present. A .140, *a* .89, T .202, H 0, C 158. Formula:

$$A - a + T - \left.\begin{matrix} H^{\circ} \\ C = \end{matrix}\right\} -.$$

Hypopepsia of the second degree (A′ — and below .100) — with pseudo-hyperacidity (A +).

CASE 61.

The patient, a lady aged 29, had suffered for many years from indigestion, the result of irregular meals, the free use of sweet pickles and other indigestible articles of food, waist constriction by corset wearing and tight waist bands, and the continuous use of purgatives. Had also taken chloride of gold and strychnia.

The prominent symptoms were choking, sensation of soreness in the œsophagus, fullness in the stomach, eructations of gas, nausea almost continuous, brief sensation of hunger a few hours after eating, constipation, hemorrhoids, gaseous distension of the bowels, many neurasthenic symptoms, especially distress of mind and insomnia, occipital headaches, burning and pressure in head, giddiness, vertigo, sensations of chilliness, trembling, especially of the legs, muscular twitching, and palpitation of the heart. The physical examination showed the stomach to be dilated, the lower border being 1½ inches below the umbilicus. Analysis of the stomach fluid showed the following quantities: A .248, A′ .087, *a* 2.72, T .190, H .014, C .086. Congo-red and methyl-violet both gave good reactions. Peptones abundant. Formula:

$$A - a + T - \left.\begin{matrix} H - \\ C - \end{matrix}\right\} -.$$

A very marked case of hypopepsia of the second degree, with pseudo-hyperacidity.

Hypopepsia of the second degree with hypoacidity — without acid fermentation.

CASE 435.

The patient was a lady of 28 years, unmarried. She had for several years been a semi-invalid, largely the result of irregular and hasty eating, eating between meals, excessive use of meats and coarse vegetables, and waist constriction. The symptoms present were morbid tastes, nausea, vomiting, attacks of pain soon after eating, "all gone" sensation in the stomach, gnawing pain at the epigastrium, recurrence of hunger soon after eating, hæmorrhoids, sleeplessness, attacks of sick headache, coated tongue, decayed teeth, lower border of stomach one inch below umbilicus, left lumbar ganglia sensitive, right kidney movable and very sensitive.

The stomach tube withdrew 40 c. c. of fluid after the usual test meal, of which 30 c. c. were left upon the filter as sediment, showing an exceedingly small amount of digestive work done. A large amount of mucus was present. The color tests indicated the absence of lactic acid, free HCl and peptones, and complete digestion of starch. Biuret showed a moderate amount of albumenoids. Rennet ferment abundant. The following figures were obtained by quantitative analysis: (A) .160; (*a*) .82; (T) .300; (H) .000; (C) .196. Formula:

$$A - a - T = \begin{matrix} H\,o \\ C+ \end{matrix} \Big\}$$

The small amount of fluid obtained in this case was evidently due to the fact that the fluid was so thick and contained such a great quantity of mucus that its removal by means of the tube was unusually difficult.

The following case of hyperpepsia of the second degree without acid fermentation, is still more remarkable.

CASE 265.

The patient, a woman aged 48 years, had suffered from digestive troubles for many years; had been addicted to hasty eating and overeating, to the excessive use of sweets, fats, and fluids, especially at meals, and overwork at sewing late at night. Symptoms: bitter taste in the mouth in the morning, tender surface upon the tongue, scanty secretion in the mouth, eructations of gas, regurgitations of fluid frequently after eating, occasional vomiting of bile and mucus without nausea, some-

times vomiting the entire amount eaten; the vomited matter bitter; cramps in the stomach; faint sensation in the stomach; good appetite; the patient has observed that vegetables, fermented bread, and strong acids disagree with her; bowels very inactive; stools whitish, mixed with opaque mucus, at times bloody and large in amount; pain at and after stools; frequent ineffectual effort to relieve bowels; gaseous distension of bowels, with odorless flatus; drowsiness after meals, also at other times; heaviness in the head, bowels, and knees; pain in back and lower part of the shoulders, also in ribs and right side; sciatica, giddiness, vertigo; noises in the head, dreams of falling, coldness between the shoulders, also of the extremities; specks before the eyes; appearance of fire; twitching of the muscles.

Physical examination showed moderate dilatation of the stomach, and prolapse of the bowels. Amount of fluid withdrawn from the stomach, 100 c. c. Result of examination of stomach fluid: (A), .012; (*a*), 0; (T), .156; (H), .012; (C), .028.

Peptones slight. Lugol's solution gave no reaction, showing complete digestion of starch. Rennet ferment absent.

Formula: $$A - a - T - \left.\begin{matrix} H - \\ C - \end{matrix}\right\} -.$$

A case of hypopepsia of the second degree, without acid fermentation.

It is interesting to note in this case the value of *a*. Recalling the formula:

$$\frac{A - H}{C} = (a),$$

and substituting the respective quantities, we have

$$\frac{.012 - .012}{.028} = \frac{0}{28} = (a).$$

The meaning of this is that although we have .028 gms. of combined chlorine in each 100 c. c. of stomach fluid, the chloro-organic compounds represented by this quantity have a neutral instead of an acid reaction and are of no nutritive value.

The hypopepsia in this case was so marked as to approach very closely to apepsia.

Hypopepsia of the second degree with hypoacidity — with acid fermentation.

CASE 13.

The patient, a physician aged 35 years, had recently suffered from an attack of *la grippe* which had left him with greatly disordered digestion. Physical examination showed marked dilatation of the stomach. Stomach tube withdrew, after the test-breakfast, 55 c. c. Analysis gave the following figures: (A), .010; (A′), .0017; (*a*), 5.00; (T), .100; (H), .000; (C), .002.

Formula: $$A - a + T - \left.\begin{matrix} H & o \\ C & - \end{matrix}\right\} -.$$

A most pronounced case of hypopepsia of the second degree, with acid fermentation.

CASE 62.

A lady, aged 65 years, had suffered for years from frequent attacks of great pain in the stomach, which occurred at such short intervals that the pain was nearly continuous, and burning in character; also suffering from pain in the region of the liver and in the left side and from morbid taste. The stomach fluid contained a considerable amount of mucus. The following quantities were obtained by analysis: (A), .175; (A′), .096; (*a*), 2.11; (T), .260; (H), .040; (C), .064

Formula: $$A - a + T - \left.\begin{matrix} H & = \\ C & - \end{matrix}\right\} -.$$

In this case the free HCl (H) is normal in amount, but the case is nevertheless one of hypopepsia of a very pronounced type. Such cases are rare, but do exist, and emphasize the importance of a method of investigation which gives exact rather than presumptive data.

Hypopepsia of the third degree — apepsia. — I have observed two cases of this sort, the most typical one of the two being herewith presented.

The analysis of the patient's stomach fluid easily explained the anæmic and emaciated condition which existed, and the extreme exhaustion which had baffled all attempts to afford relief by the aid of tonics or other palliative measures.

Addendum to follow page 42.

CASE 63.

The patient, a married lady aged 45 years, had suffered from dyspepsia for a number of years. The patient attributed her stomach disorder to the use of coffee. The principal symptoms were nausea and movements of the bowels occurring immediately after eating, palpitation of the heart, sleeplessness, neuralgia, a great variety of neurasthenic symptoms, rheumatic pains in the limbs, great emaciation and anæmia, tenderness of the solar plexus, and of the lumbar ganglia of the sympathetic, also extreme hyperæsthesia of the pneumogastrics, right kidney palpable and sensitive, hyperæsthesia of the spine and intercostal nerves. The following quantities were obtained by analysis: (A), 0; (*a*), .00; (T), .130; (H), .000; (C), .060.

Formula: $$A\ 0,\ a\ 0,\ T - \frac{H\ 0}{C - }$$

The color reagents agreed with the quantitative analysis, in indicating the entire absence of free hydrochloric acid. Biuret reaction showed the entire absence of peptone, although the value of (C) indicates a small amount of combined chlorine. That this was not a normal product, however, is evidenced by the total absence of acidity. In another analysis made a few weeks later, the amount of free hydrochloric acid found present, was gms. .008, and the stomach fluid was found acid.

The following case, observed since the publication of this paper, illustrates another very interesting form of apepsia, which I think has not been previously described. It is, however, simply a variety of the preceding, the only difference being that acid fermentation is added to the apepsia. In this case (No. 483) the following quantities were found: (A), .010: (*a*), 2.50; (T), .108: (H), .000; (C), .004.

Formula: $$A - a + T - \frac{H\ 0}{C - } - 1.$$

The color reactions were all negative. Lugol's solution showed complete digestion of the starch. Rennet ferment and rennet zymogen both entirely absent. Biuret reaction for peptone, negative. It is evident that, in this case, notwithstanding the fact that the stomach fluid was acid, no actual work was done by the stomach, and that the acid was the result of fermentation.

Simple Dyspepsia.—The following cases, which for lack of space we will present as briefly as possible, represent the four forms of simple dyspepsia which are recognized in our classification : —

Simple dyspepsia, typical, without fermentation (*a*=).

CASE 247.

A young lady, aged 23 years. Amount of stomach fluid, 175 c. c. (A), .228 ; (*a*), .85 ; (T), .312 ; (H), .032 ; (C), .232.

Peptones abundant ; starch digestion moderate ; rennet zymogen abundant.

Formula : $$A + a = T = \begin{matrix} H = \\ C + \end{matrix} \Big\} +.$$

The deviation from the normal chemism of the stomach is not sufficient in this case to relegate it to any of the classes of morbid digestion. It is simple dyspepsia without acid fermentation. The high value of (*a*) which is practically normal, indicates the good quality of the chloro-organic compounds represented by (C). There was moderate dilatation of the stomach as shown by examination, as well as by the large quantity of liquid present at the end of the hour, which does not exceed, in healthy stomachs, 40 c.c.

Simple dyspepsia, qualitative, without acid fermentation.

CASE 53.

Patient, a married lady of middle age, had suffered for several years from a variety of symptoms indicating disorders of digestion, which were probably the result of overwork, both mental and physical, and the use of stimulating medicines, which had been freely used. The most prominent symptoms were bad taste in mouth, eructations of gas, regurgitations of food, nausea, vomiting of food and bile, gnawing pain at the stomach, capricious appetite, inability to use fluids, obstinate constipation for several years, gaseous distension of bowels, nervousness and morbid fears, loss of spirits, impaired memory and loss of energy, fidgets, insomnia, occipital headache, heaviness and aching in the limbs, pain between the shoulders, pain under the ribs, pain in the lower part of the back and thighs,

frightful dreams, nightmare, sudden waking from sleep with fright, coldness of extremities, sensation of burning and feverishness after meals, ringing in the ears, specks before the eyes, formications and numbness in limbs, weariness, palpitation of the heart, shortness of breath, excessive secretion of urine, moderate dilatation of stomach, sensitiveness of the lumbar ganglia of the sympathetic, prolapse of colon.

The quantities obtained by chemical analysis after test breakfast were as follows: Quantity, 80 c. c.; (A) .172; (*a*) .67; (T) .380; (H) .034; (C) .206; peptone reaction good.

Formula:

$$A - a - T + \begin{matrix} H = \\ C + \end{matrix} \Big\} +$$

In this case the acidity was slightly below normal. This was due, not to the deficiency of the stomach work, but to the poor quality of the chloro-organic compounds; in other words, to an excessive formation of neutral chloro-organic compounds, as is evidenced by the greatly diminished value of *a*. This is very clearly shown by determining the value of A′ by the method previously described, which is .211. If the chloro-organic compound (C) possessed the normal value, the total acidity in this case would be .211 instead of .172.

Simple dyspepsia and hyperchlorhydrie, with acid fermentation.

Case 116.

A lady aged 24 years, who had spent a number of years in boarding school, was suffering from severe constipation of the bowels, hemorrhoids, inability to concentrate the mind, and extreme nervous irritability, giddiness, sudden loss of strength, general exhaustion, general muscular weakness and debility. Her condition had usually been attributed to overwork in school. The patient had not considered herself a dyspeptic, but the physical examination showed a badly coated tongue and a relaxed condition of the abdominal muscles; the right kidney was movable and sensitive. By means of the stomach tube, 113 c.c. of fluid was withdrawn after the usual test breakfast, an examination of which furnished the following data: (A), .200; (*a*), .88; (T), .286; (H), .002; (C), .224.

Lactic acid was present, and the biuret reaction showed a considerable amount of peptone. The following formula represents the chemical work of the stomach in this case:

$$A = a + T - \left.\begin{matrix} H - \\ C + \end{matrix}\right\} +.$$

A case of simple dyspepsia without hyperacidity with hyperchlorhydrie and deficiency of hydrochloric acid, or hypohydrochlorie, and slight acid fermentation.

CASE 89.

The patient aged 42 years. Amount of stomach fluid, 165 c.c.; (A), .200; (*a*), .89; (T), .284; (H), .020; (C), .202.

Formula: $$A = a + T - \left.\begin{matrix} H - \\ C + \end{matrix}\right\} +.$$

In this case also the amount of disturbance of the stomach process is so slight that it may be classed as a simple dyspepsia with acid fermentation, probably due to the delay of the stomach in emptying itself of its contents.

Simple dyspepsia with hypochlorhydrie and acid fermentation.

CASE 94.

A man, aged 55 years. Amount of stomach fluids 110 c. c. (A), .168; (*a*), .87; (T), .310; (H), .050; (C), .136.

Uffelmann's reagent showed lactic acid present. Peptones abundant. Formula:

$$A - a + T = \left.\begin{matrix} H = \\ C - \end{matrix}\right\} =.$$

A case of simple dyspepsia with hypochlorhydrie and acid fermentation. The diminished amount of useful stomach work through the failure of the chlorine to combine with albumen, and the acid fermentation which may have been greater than that shown in the value of (*a*) as suggested by the strong reaction for lactic acid, were doubtless the result of the dilated condition of the stomach which prevented the complete and prompt emptying of the organ, and so gave rise to a slight degree of disturbance of the normal chemical process of digestion, and occasioned the setting up of a vicious chemical process in the form of acid fermentation.

As the work upon which this paper is based includes, so far as the writer knows, the largest number of cases which have been studied by so exact methods of investigation, I think it important to present a brief summary of the results obtained, which will show at a glance the relative frequency of the pathological conditions which are recognized by this mode of investigation, and as will appear, indicate that some of the current notions upon this subject are quite erroneous. With reference to the three general classes, hyperpepsia, hypopepsia, and simple dyspepsia, the cases were divided as follows: —

Hyperpepsia	170
Hypopepsia	117
Simple dyspepsia	34

In considering these figures, it should be remembered that hyperpepsia and hyperacidity are by no means coincident conditions; and that each of the three groups included in hyperpepsia has a sub-group in which the acidity normal or below. The old method of analysis would place all of these cases in hypopepsia; but as the cases given show, and as will appear still more clearly from the summary of the particular conditions observed for each group, many cases of hypoacidity are really cases in which there is an excess of stomach work rather than a deficiency, and hence belong to the class of hyperpepsia rather than hypopepsia.

The accompanying tables present at a glance the particular facts observed as regards the relative frequency of excess, deficiency, and equality, in the figures found by analysis in relation to the coefficient of digestive work (a), the total chlorine (T), the free HCl (H), the combined chlorine (C), and the sum of free HCl and combined chlorine (H+C), representing the amount of chlorine set free from the bases and prepared to enter into the work of digestion.

The tables also show the relative frequency of the different forms of hyperpepsia, hypopepsia, and simple dyspepsia, and the dominant characteristics of each group. The following facts presented by the tables are especially worthy of note: —

Hyperpepsia.— The 170 cases found in this class constitute 52.9% of the total number of cases studied.

TABLE I.—SUMMARY OF THE RESULTS OF THE CHEMICAL ANALYSIS OF THE STOMACH FLUID IN 321 CASES OF DISORDERED DIGESTION, CLASSIFIED IN RELATION TO NORMAL QUANTITIES.

Class.	Group.	Sub-Group.	No. Cases.	Coefficient (a)				Total Cl (T)			Free HCl (H)				Combined Cl (C)				(H+C)		
				+	=	—	0	+	=	—	+	=	—	0	+	=	—	0	+	=	—
Hyperpepsia, 170 cases.	Hyperhydrochloric (H+) 63 cases.	Hyperacidity (A+) without a. f.	29	..	6	23	..	27	2	..	29	..	..	..	29	..	..	..	29	..	..
		" with a. f.	29	29	..	..	..	29	..	..	29	..	..	..	29	..	..	..	29	..	..
		Hypoacidity (A—) without a. f.	5	..	..	5	..	4	1	..	5	..	..	..	5	..	..	..	5	..	..
	Hypohydrochloric (H—) 74 cases.	Hyperacidity (A+) without a. f.	29	..	7	22	..	11	12	6	..	..	29	..	29	..	..	..	29	..	..
		" with a. f.	37	37	..	..	..	19	13	5	..	..	37	..	37	..	..	..	37	..	..
		Hypoacidity (A—) without a. f.	8	..	..	8	..	3	5	..	..	..	8	..	8	..	..	..	7	1	..
	Hypochlorhydric (C—) Useful Work Deficient. 33 cases.	Hyperacidity (A+) without a. f.	1	..	..	1	..	1	..	..	1	..	..	..	..	..	1	..	1	..	..
		" with a. f.	9	9	..	..	..	8	1	..	9	..	..	..	..	..	9	..	3	6	..
		Hypoacidity (A—) without a. f.	12	..	..	12	..	8	2	2	12	..	..	..	..	..	12	..	1	5	6
		" with a. f.	8	8	..	..	..	7	1	..	8	..	..	..	..	..	8	..	1	3	4
		Pseudo-hyperacidity (A+A'—) with a. f.	3	3	..	..	..	2		1	3	..	..	..	..	..	3	..	..	1	2
Hypopepsia, 117 cases.	1st Degree. (A— but above .100 gms.) 58 cases.	Hypoacidity (A—) without a. f.	29	..	..	29	..	2	3	24	..	2	24	3	10	6	13	..	..	8	21
		" with a. f.	18	18	..	..	..	3	6	9	..	4	13	1	1	7	10	..	..	1	17
		Pseudo-hyperacidity (A+A'—) with a. f.	11	11	..	..	..	3	2	6	..	4	7	...	1	3	7	..	..	4	7
	2d Degree. (A— and below .100 gms). 57 cases.	Hypoacidity (A—) without a. f.	35	..	..	32	3	1	1	33	..	3	28	4	..	..	34	1	..	..	35
		" with a. f.	19	19	..	..	..	2	4	13	..	4	12	3	..	..	18	1	..	..	19
		Pseudo-hyperacidity (A+A'—) with a. f.	3	3	..	..	..	..	1	2	..	2	1	..	..	..	3	..	..	..	3
	3d Degree—Apepsia (A0). 2 Cases.	Neutral (A0)	2	..	..	..	2	..	..	2	..	..	..	2	..	..	2	..	..	..	2
Simple Dyspepsia, 34 cases.	Without Fermentation. 19 cases.	Typical (a=)	5	..	5	..	..	1	3	1	1	2	2	..	5	..	..	..	4	1	..
		Qualitative (a—)	14	..	..	14	..	1	7	6	..	8	6	..	10	4	..	..	6	7	1
	With Fermentation. 15 cases.	Hyperchlorhydric (C+)	14	14	..	..	..	4	4	6	..	9	5	..	10	4	..	..	5	9	..
		Hypochlorhydric (C—)	1	1	..	..	..	..	1	..	..	1	..	..	..	..	1	..	..	1	..

TABLE II.—GENERAL SUMMARY OF THE RESULTS OF THE CHEMICAL ANALYSIS OF THE STOMACH FLUID IN 321 CASES, CLASSIFIED IN RELATION TO NORMAL QUANTITIES.

Class.	Group.	No. Cases	Acidity (A)				Coefficient (*a*)				Total Cl (T)			Free HCl (H)				Combined Cl (C)				(H+C)		
			+	=	—	0	+	=	—	0	+	=	—	+	=	—	0	+	=	—	0	+	=	—
Hyperpepsia 170 Cases.	Hyperhydrochlorie (H+)	63	58	..	5	..	29	6	28	..	60	3	...	63	...	...	..	63	...	...	..	63	..	...
	Hypohydrochlorie (H—)	74	66	..	8	..	37	7	30	..	33	30	11	...	...	74	..	74	...	...	..	73	15	...
	Hypochlorhydrie (C—)	33	13	..	20	..	20	..	13	..	26	4	3	33	...	...	..	...	...	33	..	6	1	12
	Total	170	137	..	33	..	86	13	71	..	119	37	14	96	...	74	..	137	...	33	..	142	16	12
Hypopepsia 117 Cases.	1st Degree (A—, but above .100 gms.)	58	11	..	47	..	29	..	29	..	8	11	39	...	10	44	4	12	16	30	..	...	13	45
	2d Degree (A— and below .100 gms)	57	3	..	54	..	22	..	32	3	3	6	48	...	9	41	7	...	...	55	2	...	..	57
	3d Degree — Apepsia (A 0)	2	...	..	...	2	...	..	...	2	...	...	2	...	...	...	2	...	...	2	..	...	..	2
	Total	117	14	..	101	2	51	..	61	5	11	17	89	...	19	85	13	12	16	87	2	...	13	104
Simple Dyspepsia 34 Cases.	Without Acid Fermentation	19	4	8	7	..	...	5	14	..	2	10	7	1	10	8	..	15	4	...	..	10	8	1
	With Acid Fermentation	15	5	9	1	..	15	..	...	..	4	5	6	...	10	5	..	10	4	1	..	5	10	...
	Total	34	9	17	8	..	15	5	14	..	6	15	13	1	20	13	..	25	8	1	..	15	18	1
	Grand Total	321	160	17	142	2	152	18	146	5	136	69	116	97	39	172	13	174	24	121	2	157	47	117

1. *Hyperpepsia with Hyperhydrochlorie* (*H*+).— The first group of this class, hyperpepsia, with hyperhydrochlorie, or free HCl in excess, presents sixty-three cases, which is 19.6% of the entire number of cases studied, or 37% of all the cases of hyperpepsia. This is by far the largest single group found. In this group, A is of course nearly always +, yet we find A — in five cases, although, as will be noticed, free HCl (H) and combined chlorine (C) are + in all the cases of this group. It is evident, then, that these five cases could not be properly classed as cases of hypopepsia. The total chlorine is found in excess in 60 of the 63 cases.

An interesting fact especially worthy of note in relation to this group is the frequency with which *a*— occurs. Since the figures represented by *a* are an index to the quality of the digestive work done, or, at any rate, to the chemical quality of C, indicating, when deficient, the presence of neutral chloro-organic compounds, which are as much greater in proportion as *a* is less than normal, it is evident that in this group of hyperpepsia, in which we find both H+ and C+, and with rare exceptions A+ and T+, or hyperacidity and excessive secretion of chlorine, the digestive product is, if not in the majority of cases, in at least a large minority (42.8%), inferior in quality, a fact which accounts for the remark often made by this class of patients, "Doctor, I have a ravenous appetite; I eat more than I ought to eat, and I seem to digest my food without difficulty; nevertheless, I lose in weight continually, and cannot gain an ounce of flesh."

2. *Hyperpepsia with Hypohydrochlorie* (*H*—). — In this group, characterized by a deficiency of free HCl, we find seventy-four cases, 23% of the total number of cases studied, or 43.5% of the cases of hyperpepsia. This group is only exceeded by the preceding in the number of cases which it presents.

It is noticeable that the total chlorine is in excess much less frequently in this group (44.6%), as compared with the preceding (95.2%). The less frequency with which hyperacidity occurs in this group, and the smaller proportion of cases in which the total chlorine is in excess, indicate distinctly that in this

group the hyperpepsia is less pronounced than in the preceding. A careful study of the cases in this and the preceding group show a gradually descending scale reaching from the most pronounced hyperpepsia down to hypopepsia. The most attenuated cases, in fact, seem to overlap the first group of hypopepsia, so that a fourth division of hyperpepsia with hypohydrochlorie (H — A —, + a. f.) would coincide with the first division of hypopepsia of the first degree.

Hyperacidity is the dominant condition as in the preceding group, although likewise not absolutely constant; for we find A — in four cases, notwithstanding that the amount of combined chlorine present is in so great excess as to more than compensate for the deficiency of free HCl in every case, so that we find in all the cases of this group (H + C) in excess. Evidently there is a sufficient amount of chlorine set free from the bases to give a figure for A in excess of the normal in every case. The hypoacidity is then due in these cases to the presence of neutral chloro-organic compounds, shown by the diminution of *a*. It will be noted, however, that A — occurs more frequently in this group (10.8%), than in the preceding (7.9%), while *a* — is slightly less frequent.

3. *Hyperpepsia with Hypochlorhydrie* (*C*—). — The value of the method of chemical investigation of stomach fluids to which it is the purpose of this paper to call attention, is especially apparent in the study of this group of cases of hyperpepsia. In fact, it is only by the aid of this method that it is possible to discover these cases, and to form of them a distinct group. The older methods give their characteristic reactions in the presence of both free HCl and combined chlorine, and hence afford no means of distinguishing between these two important conditions of the chlorine participating in the digestive act; and hence a recognition of these conditions by a careful determination of the quantity of chlorine in each state in a given case, affords our only means of determining how much of the chlorine set free from the bases with which it is combined when secreted by the stomach, really enters into the digestive process by combining with albumen for the conversion of the latter into peptone.

The 33 cases comprised in this group constitute 10.2% of the entire number of cases studied, or 19.4% of the cases of

hyperpepsia. It will be noted that A — occurs in nearly two thirds of the entire number of cases, showing at once the fact that the combined chlorine (C) is a more important element in the production of the normal acidity of the gastric juice than is free HCl (H).

The total chlorine is in excess in 78.9% of the cases, a much larger proportion than in the preceding group. Free HCl is in excess in all the cases, although the total amount of chlorine set free, shown by the sum of H and C (H + C) is deficient in 36.3% of the total number of cases, being in excess in only six cases, or less than one fifth of the entire number of cases in this group.

The quality of the digestive product is also poor, however, in a large proportion of cases, as shown by the low value of *a*, which is below normal in thirteen cases, or 39.4% of the total number, and also by the absence of peptones from the stomach fluid. It thus appears that in this group both phases of the chemical process are faulty.

This group, notwithstanding the large proportion of cases of hypoacidity (63.6%), is evidently allied to the preceding groups, although the general formula furnished by the cases of hypoacidity in this group is also very closely allied to the formula found in the first group of hypopepsia. One characteristic peculiarity alone distinguishes the formulæ of this group from those of hypopepsia of the first degree; namely, the excess of free HCl, or H +, which is always present in this group, associated with C —, but is never found in hypopepsia. It will also be noticed that in all the sub-groups of this class of hyperpepsia, T + (total chlorine in excess) occurs most frequently, T = and T — only occurring in the third and fifth subdivisions of the group, its most attenuated forms, which approach very closely to hypopepsia, as does the third form in each of the preceding groups.

Both groups may be said to touch the line of hypopepsia, as has been already remarked.

4. In the total summary of the characteristics exhibited by hyperpepsia in its different forms, we find A + in 80.6% of the cases of hyperpepsia; A — in a little less than one fifth of the cases, while A = is absent. It should be mentioned, however, that A + includes a few cases in which the total acidity was

close to the extreme upper limit of normal variation, and A— two or three cases in which A was close to the lower limit. A= is a characteristic of simple dyspepsia.

The coefficient *a* is below normal in 71 (41.7%) of the cases. *a* = occurs in only 13 cases, being one of the characteristics of simple dyspepsia. The total chlorine is equal, or in excess, in 156 cases (91.8%), being found deficient in only 14 (8.2%) of the cases.

H+ occurs in 96 (56.5%) of the cases, and H— in 74 (43.5%) of the cases. We find C (combined chlorine) in excess in 137 (80.6%) of the cases, and deficient in 33 (19.4%) of the cases. (H + C) is in excess in 142 (83.5%) of the cases, equal in 16 (9.4%) of the cases, and deficient in 12 (7.1%) of the cases.

Hypopepsia. — The total number of cases of hypopepsia was found to be 117, 36.4% of all the cases examined, a much smaller number than would be supposed by the frequency with which hydrochloric acid is administered to patients by physicians and the great quantities of pepsin and other digestive agents, and digested or partially digested food substances, annually swallowed by dyspeptics. A careful study of the chemistry of digestion in pathological cases shows that deficient digestive work is not the chief fault in the majority of cases of disordered digestion, but abnormal or vicious chemical work. My statistics show unmistakably that in a great proportion of cases of indigestion, the stomach is even doing an excess of work; but the quality of the work done is inferior or takes a wrong direction, so that notwithstanding the great amount of labor performed by the stomach, the blood is not supplied with the proper amount of well-elaborated food substances, but instead receives a great amount of material which has been partially digested only, or has been subjected to deteriorating changes through the action of microbes and other ferments, and which must be destroyed by the liver and eliminated by the kidneys and other emunctories, along with the normal waste and excrementitious products of the tissues. It is this semi-starvation and auto-intoxication which gives rise to a great share of the morbid symptoms presented in various forms of functional stomach disorders

In hypopepsia we find a still greater deficiency of well elaborated food elements than in hyperpepsia, and yet it is not uncommon to find persons suffering from a very extreme degree of hypopepsia who are not by any means so much emaciated as we should expect to find them, and sometimes even enjoying fair health, owing to the fact that the stomach is not the chief digestive organ of the body, but only a sort of antechamber in which the preliminary digestive work is done. So it is possible for very good health to be enjoyed coincident with hypopepsia, provided a suitable dietetic regimen is followed, and even though the stomach may be almost wholly inactive in the digestive process.

As before stated, I have followed the plan of Hayem and Winter in grouping cases of hypopepsia, since their method, although wholly artificial, is as good as any that has occurred to me. The study of a still larger number of cases will perhaps enable me to find a natural and better basis of classification.

1. *Hypopepsia of the First Degree* (*A* — *or A'* —, *but above .100 gms.*). — The total number of cases in this class is 58 or 49.4% of all the cases of hypopepsia. We find here, as in hyperpepsia, a few deceptive cases, although of the opposite character. The total acidity which is usually less than normal (47 cases, 81.1%) was found to be in excess in 11 cases (18.9%). As hydrochloric acid was also present in all but three of the cases, although diminished in quantity, these cases examined by the older methods would have been pronounced cases of hyperpepsia; but that they belong to the class of hypopepsia is evidenced by the fact of the deficiency in the total chlorine (T), and also in the diminished combined value of H and C (H + C), as well as the low value of H. A — appears much more frequently than in hyperpepsia. These cases afford another interesting illustration of the importance and value of the ingenious method of investigating stomach fluids devised and perfected by Hayem and Winter, and which appears to me to be the only one of any considerable scientific value which has been proposed.

The total chlorine is in excess in but eight cases (13.8%), being deficient in 39 (67.2%) of the cases. Free HCl (H) was deficient in 44 (75.8%) of the cases, and entirely absent in four

cases (6.8%). A few cases in which it was found equal were classified as hypopepsia because of the low values of T and (H + C), showing an evident and marked diminution in both the secreting and chemical work of the stomach. The combined chlorine (C) was deficient in 30 (51.7%) of the cases, equal in 16 (27.6%), and in excess in 12 (20.7%); and (H + C) was minus in 45 (77.6%) and equal in 13 (22.4%) of the cases, never in excess.

2. *Hypopepsia of the Second Degree (A or A' —, and below .100 gms.).*— Total number of cases, 57, or 48.7% of the cases of hypopepsia. Here, as in the preceding group, we find a few cases (three, or 5.2%) of pseudo-hyperacidity. In each of these cases, as in the similar cases of the preceding group, an abnormal degree of acidity was present, due to acid fermentation and the formation of a great quantity of lactic acid and perhaps other members of the fatty acid series. That these cases belong properly to the class hypopepsia, is easily ascertained by obtaining the value of A' by the method previously described. This value was, in the three cases of hyperacidity found in this group, determined to be less than .100 gms., although the acidity was in one instance found to be .413 gms., or more than double the normal amount, the value of A' in this instance being only .086 gms., or about one half the normal, and one fifth the total, acidity. We find A less than normal in 54 (94.7%) of the cases, a considerably larger proportion than in the preceding group. T + occurs in this group in but three cases, the total chlorine being equal in only six (10.5%) of the cases and falling below normal in 48 (84.2%). The free hydrochloric acid was normal in only nine (15.8%) of the cases, below normal in 41 (71.9%) of the cases, and 0 in seven cases. C was 0 in two cases, and below normal in 55 (96.5%) of the cases. The advanced state of hypopepsia in this group is shown by the fact that the combined value of H and C (H + C) is below normal in every case, while in the preceding group this value is normal in 22.4% of the cases.

3. *Hypopepsia of the Third Degree (A 0, or Apepsia).*—Apepsia was found in only two cases, 1.7% of the cases of hypopepsia, or .6% of the cases studied. In one of the two cases of this sort which I have met, the reaction of the stomach fluid

was slightly alkaline, and the value of A was —.020. T— was found in both cases. Combined chlorine (C) was present in slight quantity in both cases.

In this group, the stomach work reaches the vanishing point, a condition which not infrequently co-exists with malignant disease, although not invariably present. When present in connection with a perceptible thickening in the epigastric region, it becomes, however, a very important aid to diagnosis, as hyperpepsia would not be likely to co-exist with such a condition except in the case of gastric ulcer accompanied by fibrous thickening. We thus have a very important means of differential diagnosis in a class of cases in which it is sometimes difficult to determine by other means whether an existing disease of the stomach is simple ulceration which may be cured, or a disease of a malignant and incurable character.

Summarized, the facts relating to hypopepsia are as follows: A— in 101 (86.3%) of the cases; A+ in only 14 (11.9%); total chlorine in excess (T+) in only 11 (9.4%) of the cases, and deficient in 89 (76%) of the cases. Free HCl, never in excess, was found deficient in 85 (72.6%) of the cases, normal in only 19 (16.2%), and was entirely absent in 13 (11.1%) of the cases. The combined chlorine was diminished in 87 (74.3%) of the cases, equal in 16 (13.6%), and in slight excess in only 12 (10.2%) of the cases. The combined value of free HCl and combined chlorine was also deficient in 104 (88.9%) of the cases, and equal in only 13 (11.1%).

Simple Dyspepsia.— This class includes 34 cases, 10.6% of the entire number studied. The cases grouped in this class are those in which there was no serious disturbance of the chemical work of digestion. The smallness of the proportion of cases is at once an indication of the importance of a careful chemical study of the stomach fluid in all cases of dyspepsia, to obtain a basis for a rational plan of treatment.

Of the cases of simple dyspepsia the total acidity (A) was found to be in slight excess in nine (26.4%), equal in 17(50%), and slightly deficient in only eight (23.5%). The coefficient *a* was found in excess in 15 (44.1%) of the cases, as the result of acid fermentation, which may be properly considered as the principal chemical disturbance met with in simple dyspepsia,

there being neither a deficiency nor an excess of chemical work to any considerable degree, but rather a vicious chemical action added to the normal work of the stomach. That this vicious action may ultimately lead to a disturbance of the normal chemical work of the stomach, I have many times seen demonstrated by the readiness with which the normal chemical work of the stomach is resumed when acid fermentation is suppressed by lavage and the employment of antiseptic measures by prescribing a proper dietary, and when necessary, antiseptic medication.

We find *a* — in 14 (41.1%) of the cases, an evidence that a deterioration in the quality of the work done by the stomach may occur without either an increase or a diminution of the amount of work done; in other words, without either hyperpepsia or hypopepsia. T = was found in 15 (44.1%), T + in 6 (17.6%), T — in 13 (38.2%) of the cases. Free HCl was normal in quantity in 20 (58.8%), and deficient in 13 (38.2%) of the cases. Combined chlorine (C) was in excess in 25 (73.5%) of the cases. This deviation is not sufficiently serious in itself to characterize a case as abnormal, since C represents useful chemical work. An increase of combined chlorine is, according to my observation, a condition commonly present in cases in which a patient is rapidly gaining in flesh. The combined value of H and C (H + C) was slightly in excess or equal in nearly all the cases (33, or 97%).

General Summary.— A brief glance at the grand totals of the chemical facts contained in the table shows hyperacidity to be present in 160 (50%) of the cases; hypoacidity was found in 142 (44.2%) of the cases. The acidity was normal or equal in 17 (5.2%) of the cases, and wholly absent in two (.6%) of the cases.

The coefficient of chemical stomach work, shown by the value of *a*, was in excess in 152 (47.4%) of the cases, deficient in 146 (45.4%) of the cases, equal in 18 (5.6%) of the cases, and 0 in five cases (1.6%).

The total chlorine was in excess in 136 (42.4%) of the cases, deficient in 116 (36.1%), and equal in 69 (21.5%) of the cases.

Free HCl was in excess in 97 (30.2%), deficient in 172 (53.5%), equal in 12.2% of the cases, and entirely absent in 13

(4.1%) of the cases. Combined chlorine (C) was in excess in 174 (54.2%), deficient in 121 (37.7%), equal in 24 (7.5%), and totally absent in two cases. The combined value of H and C (H + C) appeared in excess in 157 (48.9%) cases, deficient in 117 (36.5%) cases, and equal in 47 (14.6%) cases.

Acid Fermentation.— It is interesting to note the relation of acid fermentation to the several classes described. As indicated by the value of *a*, fermentation was present in 86 (50.6%) of the cases of hyperpepsia, in 51 (43.6%) of the cases of hypopepsia, and 15 (44.1%) of the cases of simple dyspepsia; from which it appears that acid dyspepsia is a more frequent accompaniment of hyperpepsia than of hypopepsia. This fact would seem at first sight to oppose the opinion generally held that the free HCl of the gastric juice is a natural antiseptic, and of great use in inhibiting abnormal fermentations. It seems probable, however, that in many cases, the hyperpepsia may be the result of glandular irritation and hyperactivity produced by the contact with the gastric membrane of lactic and other acids produced in excess by abnormal fermentations. That free hydrochloric acid lessens the tendency to acid fermentation in the stomach is clearly shown by a comparison of the frequency of the occurrence of fermentation in the different groups of hyperpepsia. In the first group, hyperpepsia with hyperhydrochlorie (H +), acid fermentation was found in 29 (46%) cases; in the second group, with free hydrochloric acid deficient, although (H + C) was in excess, acid fermentation was found present in 37 (50%) cases; while in the third group, hyperpepsia with hypochlorhydrie, (H + C) being in excess in only 18% of the cases, acid fermentation was found present in 20 (60.6%) cases.

Just why acid fermentation occurs less frequently in hypopepsia than in hyperpepsia, is somewhat difficult to understand. A remarkable concurrent fact, and one which I believe is new to the study of this subject, is the very complete digestion of starch in cases of pronounced hypopepsia, which I have observed in a very considerable number of cases. In fact, I have found the state of the starch digestion to be a very good index to the degree of total acidity. When A is large, Lugol's solution gives a blue, bluish purple, or purple color, showing that

the starch is unchanged or is partially or completely converted into erythro-dextrine. In well-marked cases of hypopepsia with hypoacidity, Lugol's solution gives a brown color, or no reaction whatever, showing complete conversion of the starch into sugar, an observation which is confirmed by the strong reaction for sugar given by Fehling's solution.

Through the more prompt conversion of starch into sugar in the stomach in hypopepsia, the digested starch may disappear by absorption so rapidly that the conditions become less favorable for the development of acid fermentation than in the presence of a large quantity of partially digested starch. This point is of sufficient interest to be worthy of more complete study, and I hope to be able to elucidate it more fully in some future paper.

In my studies of digestive fluids, I do not confine myself to a determination of the quantity of chlorine present in its different forms, but also employ the various color reagents, and the well-known tests for peptones, propeptones, and albuminoids, the coagulation test for rennet ferment and for the rennet zymogen, and also determine the state of the starch digestion by means of Lugol's solution. Tests are also made for lactic acid, as well as for acetic and butyric acids, and for bile and alcohol when the presence of these substances is suspected. Important facts are also ascertained from an ocular examination of the stomach fluid, from a determination of its quantity and the amount and appearance of the residue left on the filter. On the next page is a reproduction of the blank form which I have prepared for use in my own laboratory, and which I find very convenient, as it shows at a glance all the more important things relating to the chemical work of the stomach which it is possible to know.

I also sometimes employ salol for determining the state of the motor function of the stomach, and iodide of potash for ascertaining the rate of absorption; but I find so great a discrepancy in the results obtained by these methods that I cannot but consider them as of less value than the information derived by other means, especially clapotement and the stomach-tube.

The Acid of the Gastric Juice.— There has been an almost endless discussion among physiologists respecting the nature of

NO. .. ..

SANITARIUM LABORATORY OF HYGIENE.

BATTLE CREEK, MICH.

J. H. KELLOGG, M D., Superintendent.

ANALYSIS OF STOMACH FLUID.

M..... ....189..

Test-meal. Bread, fermented, unfermented.... oz., meat, eggs....oz. Water, 8 oz. Breakfast. Dinner. (Lavage two hours previous.) Duration of Digestion.....hours .....minutes.

Physical characteristics: amount.....c.c., color..... odor.....blood.....mucus.....residue .....gms.

Normal variations.*

Total acidity, (A)....gms.(A')....gms.(.180-.200 gms.)

Coefficient, (a).....(.86)

Total chlorine, (T).....gms.(.300-.340 ")

Free HCl, (H).....gms. } " { (.025-.050 ") } .180-

Combined chlorine, (C).. " } .. { (.155-.180 ") } .225.

Fixed chlorides, (F)..... " (109 gms.)

Color reactions for HCl: Congo-red...Methyl-violet..... Günzburg's reagent....Resorcine....Dried residue....

Reactions for fatty acids, etc.: Lactic.....Acetic or Formic .....Butyric. .....Bile.....Alcohol.....

Digestion of Proteids: Biuret reaction.....purple, violet Propeptones.....Rennet ferment.....Rennet zymogen.....

Digestion of Starch: Lugol's solution..blue, brown, violet, purple.

Diagnosis. Formula: A a T $\left\{\begin{matrix} H \\ C \end{matrix}\right\}$ .....

.....

Prescription.....

.....

.....

* The quantity of chlorine is expressed as HCl. The values given relate to 100 c.c. of stomach fluid.

the acid of the gastric juice. Quite a considerable number of eminent chemists have maintained that the normal acid of the gastric juice is lactic acid, and there have been physiological chemists of repute who have regarded the acidity of the gastric juice to be due, in considerable part, to acid phosphates. The majority of authorities have given their adhesion, however, to the views of Bidder and Schmidt, who regarded the acidity of the gastric juice to be due to the presence of free hydrochloric acid. The experiments of Richet and others have thrown considerable doubt upon this theory, however, and consequently much confusion has existed among physiologists upon a point which it would seem ought by this time to have been authoritatively settled. That lactic acid is normally present, in small amounts at least, in the early stages of digestion, is a fact which cannot be disputed ; and that it plays a part of some importance in the digestive process, the writer has demonstrated to his own satisfaction, although just what part it acts in the normal chemical process of digestion cannot yet be fully explained by the data which physiological and therapeutic experiments have placed in our hands. The facts which the writer desires to present, it is believed will be found of interest in this connection, and will contribute something toward the settlement of this important physiological question. The facts to be presented are as follows : —

1. The results observed respecting the constancy of free HCl in the quantitative analysis of 413 different stomach fluids.

2. The results noted as regards the presence of lactic acid in the examination of stomach fluids.

3. Experimental observations respecting the effect of the addition of free hydrochloric acid to meat juice.

4. Therapeutic observations respecting the influence of lactic acid upon the digestive process.

1. *The Results of the Quantitative Analysis of 413 Stomach Fluids.*—The stomach fluids analyzed in this series of observations, were furnished by 321 different individuals. The fluid was withdrawn from the stomach one hour after taking a test breakfast, neither food nor fluid having been taken since rising. The presence of hydrochloric acid was determined qualitatively by the use of the usual color reagents, Congo-red, methyl-vio-

let, Günzburg s reagent, and the resorcine and sugar reaction. Each fluid was also carefully examined quantitatively by substantially the same method suggested by Bidder and Schmidt, which consists in first determining the total amount of chlorine present in the gastric fluid, then making a second determination, after evaporating the liquid to dryness without the addition of carbonate of soda, and drying the residue for an hour so as to drive off all free HCl. Subtracting the figures obtained in the second analysis from those obtained in the first, the difference will represent, of course, the exact amount of HCl existing in a free state in the fluid examined. No method of determining the amount of HCl present in the gastric juice more accurate than this has ever been devised, and indeed this method seems to offer all the advantages as regards accuracy that could be desired. It is evident that the only chance for error, if any exist, would be in the representation of too small a quantity of free HCl, since in the first determination the free HCl is wholly fixed by the carbonate of soda added, so that the only source of error likely to arise, will be found in neglecting to continue the evaporation of the dried residue in the second determination for a sufficient length of time to completely dissipate the free HCl present.

The results obtained were as follows :—

(a) The presence of free HCl was indicated by color reactions in 362 cases, or 87.6 per cent of the total number examined.

(b) The presence of HCl was determined by the quantitative method, and in amount sufficient to be measured, in 397 cases, or 96.1 per cent of the total number of fluids examined.

It is interesting to note that free hydrochloric acid was found, and the amount determined by the quantitative method, in every single instance in which its presence was indicated by color reactions, although the color reagents failed to indicate the presence of free HCl in quite a number of instances in which it was present in very appreciable quantity, as determined by quantitative analysis. In one instance the color reagents totally failed to indicate the presence of free HCl, although this acid was present to the amount of .020 grams of anhydrous acid in each 100 c.c. of stomach liquid.

It appears from these results that hydrochloric acid is a very constant constituent of the gastric juice, even under unfavorable circumstances, for nearly all the cases examined were persons who were suffering more or less from stomach disorders. The sixteen cases in which no free hydrochloric acid was found by quantitative analysis, were all cases of hypopepsia of a very pronounced degree. Hypoacidity existed in all these cases, and lactic acid was present in only three of the sixteen cases.

2. *Observations Relating to Lactic Acid in the Analysis of 328 Stomach Fluids.*— The stomach fluids examined were furnished 232 different persons, nearly all of whom were suffering more or less from disordered digestion. For obvious reasons, no quantitative estimation of the amount of lactic acid present was undertaken. Uffelmann's reagent was employed with all possible precautions. A watery solution of the residue obtained by washing the liquid several times with ether, then evaporating the ethereal extract, was used, but the presence of lactic acid was indicated in only 180 cases, or 54.9 per cent of the total number of fluids examined.

The evidence respecting the degree of constancy of lactic acid as a constituent of gastric juice afforded by this fact, cannot be said to be absolutely conclusive on account of the want of a thoroughly reliable color indicator for this acid; but such evidence as exists, leads to the conclusion that this acid is much less constant as a constituent of gastric juice than is free HCl, and this observation still remains good, even if we consider lactic acid present in every case which presents any evidence of acid fermentation, since the addition to the figures above given of 59 cases of acid fermentation in which the presence of lactic acid was not noted, making 259 cases in all, would still give 21 per cent of the total number of cases examined in which lactic acid was observed to be absent.

I do not know whether or not a study of this sort, including so large a number of cases, has ever before been made, and hence am not able to make a comparison of my results with those obtained by other observers. I ought to add, however, that every precaution was taken to avoid the ingestion of lactic acid with the food, and to exclude lactic-acid-forming ferments.

To this end I discarded the use of the white raised bread commonly employed for the test breakfast, and used, instead, unleavened water-bread composed of whole-wheat meal with the addition of common salt to the amount of three fifths of one per cent of the bread taken.

Admitting the correctness of the above observations, it seems quite clearly established that free HCl is the normal acid of the human gastric juice, and that lactic acid plays only a subordinate part.

If it be suggested that the observations are inconclusive, because the digestion was disordered more or less in the majority of cases from which the fluids were obtained, this objection is negatived by a comparison of the results obtained in cases of hyperpepsia and hypopepsia respectively. Of the total number of cases examined with reference to lactic acid, 182 belonged to the class hyperpepsia, and 123 were cases of hypopepsia. Lactic acid was found present in 97 cases, or 53.3 per cent, of the cases of hyperpepsia, and in 63, or 51.2 per cent, of the cases of hypopepsia, while the proportion of all the cases examined in which lactic acid occurred, was 54.9%. If lactic acid is normally a prominent constituent of the gastric juice, we should expect to find it increased in quantity in cases in which the other elements of the gastric juice were found in excessive proportion; but, as shown by the above figures, this is not the case. We find lactic acid occurring with about equal frequency in cases of hyperpepsia and hypopepsia.

3. *Observations Respecting the Effect of the Addition of Free HCl to Meat Juice.* — The fact that free hydrochloric acid is not found in the gastric juice of dogs that have been fed on meat, has been used as an argument against the theory which regards this acid as an essential constituent of healthy gastric juice. Hayem and Winter some time ago suggested that this fact might be due to the combination of free hydrochloric acid with the albuminous elements of meat, thus causing the disappearance of HCl in a free state from the gastric fluid obtained from the stomach of a dog during the digestion of flesh food. The following experiment, a modification of an experiment made by the authors above referred to, seems to demonstrate this hypothesis to be correct: —

A quantity of meat juice was expressed from fresh beef and titrated with a decinormal solution of hydrate of potash; its acidity was found to be equivalent to .021 grams of anhydrous HCl. A solution of hydrochloric acid was then added drop by drop to an equal quantity of the same preparation of meat juice, testing frequently for the presence of free HCl. No indication whatever was obtained until after .015 grams of anhydrous HCl had been added. A faint indication of the presence of free acid was then obtained with Congo-red paper. The solution was then titrated with a decinormal solution of KHO, and its acidity was found to be an equivalent of .035 grams of anhydrous HCl, showing that the HCl added had not been neutralized by any alkaline substance in the meat juice, but that it had been simply fixed by the albumen with which it had formed an acid combination, it still retaining its acid function to the full degree.

This experiment explains very completely the absence of free HCl from the gastric juice of the dog during the digestion of meat, and of course answers completely the argument based upon this fact.

4. *Therapeutic Observations Respecting the Influence of Lactic Acid upon the Digestive Process.*— I have made a very considerable number of observations respecting the influence of lactic acid upon stomach digestion. Having noted the frequent absence of lactic acid in cases of hypochlorhydrie, lactic acid being noted as absent in 25 (61 per cent) of the 41 cases of hypochlorhydrie,— cases in which free HCl is present in the gastric juice in abundant quantity, but fails to combine with albumen to the usual extent, or, in other words, in which there is a deficient amount of useful work done by the stomach,— it occurred to me to be possible that the qualitative change in the character of the chemical work done by the stomach might be due to this notable deficiency of lactic acid, which previous experience had taught me to be useful in certain cases of dyspepsia, although I had not before been able to predict in advance just which cases would be benefited by the remedy. I accordingly began the administration of the lactic acid in doses of 5–15 minims of pure acid in cases of this class, and with the

most excellent results, as will be seen by the following case, which is a fair example of many others which might be cited :—

A young man aged 30, a student, had suffered for eight or ten years from stomach disorders which had been but partially relieved by the various remedial measures which he had employed. Was emaciated, and suffered much from sour stomach. Appetite was good, but the nutritive processes were evidently very defective, for he was continually emaciated and weak, and unable to pursue his studies except under great difficulty.

Analysis of the stomach fluid gave the following quantities : (A), .217 ; (*a*), 1.00 ; (T), .354 ; (H), .090 ; (C), .120.

Formula : — $$A + a + T + \left.\begin{matrix} H + \\ C - \end{matrix}\right\} =$$

The above figures indicate hyperpepsia with hyperchlorhydrie, hyperacidity, and acid fermentation. The amount of free hydrochloric acid is notably large — nearly double the maximum quantity found in health ; but fermentation existed notwithstanding the presence of this large quantity of free HCl, a circumstance which I have observed in many other cases. The patient had occasionally found relief by the use of lactopeptine. At my suggestion, he discontinued the use of this remedy, and used lactic acid instead — 5 to 10 drops immediately after each meal, sometimes repeating the dose one half hour to one hour after the meal. Sept. 7, 1892, a month after the first analysis, another test breakfast was taken, and the following figures were obtained : (A), .188 ; (*a*), .81 ; (T), .284 ; (H), .020 ; (C), .204 :

Formula : — $$A = a = T - \left.\begin{matrix} H - \\ C + \end{matrix}\right\} =$$

Uffelmann's test for lactic acid gave no reaction. Peptones abundant. This formula indicates simple dyspepsia with slight deficiency of free HCl, without acid fermentation. It is interesting to note that under the influence of the lactic acid the excessive secretion of chlorine had disappeared, the fermentation ceased, and the large quantity of free HCl which remained in the stomach unused, was made to combine with the albumen,

and thus enter into the useful chemical work of the stomach. The excess of the combined albumen (C) cannot be considered a pathological condition in this case, as it only indicates the effort of nature to supply the extra quantity of nutritive material needed for promoting a gain in flesh. Under the influence of this simple remedy alone, having made no change whatever in his diet, the patient had gained several pounds in flesh, and was so greatly improved that he considered himself practically well. He was advised to continue the use of the lactic acid for some time longer.

Similar observations respecting the therapeutic value of lactic acid have been made in a very large number of cases, with equally good results, the details of which will be recorded in another paper devoted to the treatment of functional stomach disorders.

The following summary relating to other data than that pertaining to the chlorine of the gastric fluid may be of interest:—

Sex.—Of the whole number of cases examined, 30% were men and 70% women. The proportion of males to females found in each of the three great classes of dyspepsia is as follows:—

In hyperpepsia the proportion was found to be, for males, 34.6%; females, 65.4: in hypopepsia, for males, 24.8, females, 75.2%: in simple dyspepsia, for males, 26.5%; females, 73.5%. It thus appears that men are more susceptible to hyperpepsia than are women, while hypopepsia is the most common form of stomach disorder in women.

Digestion of Proteids.—Out of 261 cases, peptones were abundant in 183; reaction for peptones was feeble in 32 cases, and absent in 44 cases. The reaction for albuminoids was also absent in 11 cases.

The rennet ferment was present in abundance in 77.1%; was entirely absent in 13.8%; was present in the form of zymogen in two cases in which it could not be detected in the form of rennin; and was entirely absent as rennin or rennet zymogen in 7.6% of the cases.

Starch Digestion.—In 149 cases in which starch digestion was especially studied, the purple color of erythrodextrine was found in 67.8%; the digestion of starch shown by the blue color was

present in 2%; good digestion of starch, shown by brown coloration, in 17.4%, and complete digestion, indicated by no reaction, in 2% of the cases.

Quantity of Fluid Obtained. — The quantity of fluid obtained in normal cases is 40 c.c. Eighty to 100 c.c. was found in 32.3% of the cases, and more than 100 c.c. in 67.7%.

Residue. — The residuum was found to be less than one fourth of the entire quantity of fluid withdrawn in 20.7%, more than one fourth and less than one half in 62.9%, and more than one half in 16.4% of the cases.

Mucus. — Mucus was present in considerable quantity in 45.1%, in very small quantity in 46.3%, and absent in only 8.6%, indicating very clearly the relation of stomach catarrh, or excessive secretion of stomach mucus, to functional stomach disorders.

Lactic Acid. — Lactic acid was in excess in 34.2% of the cases, diminished in 23.5%, and absent in 42.3%.

Dilatation of the Stomach. — Dilatation of the stomach was observed in 42% of the cases.

Hyperæsthesia of the Sympathetic Ganglia. — Hyperæsthesia of the solar plexus and of the lumbar ganglia of the sympathetic was present in 29.6% of the cases.

Kidney Displacement. — Mobility or displacement of one or both kidneys was found in 14.6% of the cases.

It would also be of interest to study the relation of the data above presented to the several classes, groups, and sub-groups of dyspepsia, but this study must be deferred for a future paper.

As regards the treatment of the various conditions with which we are made acquainted by a careful chemical investigation of the products of digestive work obtained from the stomach when in full activity, I have not space in this paper to do more than simply call attention to the fact that the requirements of each individual case are by this method so clearly defined, and so explicitly indicated, that there can be no doubt as to what needs to be done. After obtaining the data furnished by the chemical investigation, noting also the quantity of the fluid withdrawn, one has but to make a formula to be enabled to see at a glance what are the therapeutic indications in the particular case. For example, if in a given case the formula found

is $A + a + T + \left.\begin{matrix} H+ \\ C+ \end{matrix}\right\} +$, the fact is discovered instantly that the case in hand is one of hyperpepsia with hyperhydrochlorie, hyperacidity, and acid fermentation. Whether or not the hyperacidity is due to acid fermentation alone, can be readily ascertained by determining the value of A′, which should always be done whenever we find $a +$. If A′ is above normal, then we have hyperacidity due to hyperhydrochlorie, and to this is superadded the acidity resulting from acid fermentation. If the acidity resulting from acid fermentation is very considerable in amount, and especially if the quantity of fluid drawn from the stomach is large, we know at once that the first measure to be employed in the case, unless strongly contra-indicated by some other pathological condition, is lavage. It is surprising indeed how quickly acid fermentations may be suppressed by simply washing out the stomach, at the same time so ordering the patient's dietary as to avoid the introduction or development of microbes; in other words, employing an aseptic diet.

The superiority of a method which determines, quantitatively, the amount of chlorine present in the stomach fluid, and the exact amount of chlorine present under the several conditions in which this element is found in the stomach fluid, is well shown by the following case :—

The patient (Case 68), a married lady about 50 years of age, had suffered for many years from stomach disorders more or less pronounced. The quantities obtained after the test breakfast were as follows : (A), .272 ; (A′), .251 ; (*a*), .96 ; (T), .384 ; (H), .058 ; (C), .224.

The color reactions were as follows : Congo-red indicated the presence of free acid. Methyl-violet gave only a very slight reaction, indicating a very small amount of hydrochloric acid in a free state, notwithstanding the fact that it was actually present in excess. Uffelmann's reagent indicated the presence of lactic acid.

It is evident that without the quantitative chemical analysis in this case, the real nature of the case could not have been understood. The slight indication of the methyl-violet reaction would suggest that the excessive acidity was due to the fermentation, which would be considered as confirmed by the reaction

for lactic acid. The determination of the actual quantities of chlorine present, however, shows us that the amount of fermentation is very slight, *a* being normal at .86, and that the quantities of free HCl (H) and combined chlorine (C) present, are sufficient to give an acidity of .251, the significance of which is readily seen by comparing these figures with the normal quantity .180 to .200; in other words, the chemical investigation affords most conclusive evidence that the hyperacidity is due, not to acids resulting from fermentation, but to an excess of HCl secreted and set free. In the following case, the same point is illustrated, and an additional one of fully equal importance: —

The patient, a married lady of 35, was a chronic dyspeptic. Sixty-nine c.c. of stomach fluid were obtained after a test meal, in which a considerable amount of mucus and residue were found. Analysis gave the following quantities: (A), .320; (*a*), 1.35; (T), .340: (H), .074; (C), .182.

Congo-red indicated the presence of free acid, but methyl-violet gave only a very slight reaction. Uffelmann's reagent gave the reaction for lactic acid. If the color reagents had been relied upon without the quantitative analysis, this case, as the other, might have been regarded as a case of excessive acidity due to fermentation alone, whereas there was not only fermentation but also hyperpepsia of a very considerable degree, as is readily seen by comparing the above figures with the normal, the combined chlorine and the free HCl (H+C) being in excess, and the value of A′ being considerably above normal, namely .231. A great amount of fermentation is also shown to be present, as indicated by the high value of *a*. This is a case of hyperpepsia with acid fermentation. In this case, however, the fermentation is the chief morbid condition, as but one fourth of the excess of acidity is due to normal elements. By no other known means could the exact conditions present in this case have been accurately ascertained.

In the cases mentioned above, the fermentation was quickly suppressed by lavage, aseptic diet, and antiseptic medication, and the patient made rapid and marked improvement.

The excess of free hydrochloric acid, and of the total chlorine, indicates usually a glandular irritation resulting in exces-

sive secretion. There is often found (29.6%) great hyperæsthesia of the solar plexus, the lumbar ganglia, and sometimes other portions of the abdominal sympathetic, the relation of which to functional disorders of the stomach is a matter of great interest, but of too large proportions to be considered in this paper. This glandular and nervous hyperæsthesia or irritability must be lessened by the employment of an appropriate dietary, soothing remedies, such as subcarbonate or subnitrate of bismuth, galvanism, and the various resources of hydrotherapy adapted to such cases. By the aid of massage, skillfully administered, the relaxed stomach may be emptied of its contents before fermentation has become far advanced. By these and other means the return of the stomach process to a normal channel may be facilitated, and generally the *vis medicatrix naturæ* is competent to restore to a normal state the vital activity of the stomach when favorable conditions are applied, so that the patient quickly experiences wonderful relief; and the satisfaction afforded to the doctor by the gratitude of his patient is ample compensation for the painstaking investigation required to put him upon the right track.

The chart which I present with this paper exhibits a classification of all the different forms and types of dyspepsia which I have encountered in a very careful study of 600 analyses, and shows at a glance the therapeutic indications of each. The best means of meeting these indications may not be in all cases known to us at present, although the results which I have obtained are such that I do not feel any hesitancy in saying to any patient whose stomach disorders are clearly functional, that he may confidently expect relief within a reasonable length of time by the employment of the rational measures with which we are acquainted, and which the precise knowledge afforded by accurate means of investigation enable us to employ with far greater satisfaction and success than heretofore. We have long been possessed of abundance of artillery and ammunition with which to fight the hydraheaded disease, dyspepsia, which is perhaps responsible for more human ills and woes than any other malady; but our efforts have been often fruitless be-

cause we were obliged to aim our artillery without precision, like firing at an enemy concealed in a fog-bank.

The new facts which have come to us through the brilliant results of the labors of the eminent French physiologists who have given to us the new method of analysis described in this paper, illuminates this subject with the light of a noonday sun, and renders interesting — I may even say fascinating — the study and treatment of a class of disorders which have been heretofore so disappointing and so baffling as to render to many physicians the very sight of a chronic dyspeptic, obnoxious and repulsive. Although for twenty years my professional work has been done under such circumstances as to bring me in contact constantly with a very large number of obstinately chronic cases belonging to this class of sufferers, I confess I have fully shared the sentiments above expressed, with my medical brethren, and have only really experienced genuine satisfaction — I may almost say delight — in meeting an old dyspeptic, since I have based my treatment of these cases upon positive facts furnished by a rigid chemical investigation, instead of trusting to hypothetical theories, intuition, or even experience, which is a dear school to learn in, — at least for our patients, — and unfortunately teaches wrongly almost as often as rightly. No therapeutic experience could be more interesting than to watch a bad type of indigestion gradually rising from the lowest depths of hypopepsia through the lesser degrees of this morbid state, by and by reaching simple dyspepsia, or some attenuated form of hyperpepsia, and finally assuming those normal characters which indicate a restoration to perfect health. The only possible objection that can be raised to this investigation of stomach disorders is the fact that it is inconvenient for both patient and physician. I have found, however, without a single exception, that patients who have long suffered the pangs of chronic dyspepsia, are very ready to submit to the slight inconvenience accompanying the skillful passage of a small stomach tube, and many patients find the operation so little disagreeable that they are inclined, from curiosity to learn what progress they are making, to desire the passage of the tube too frequently. By a general and skillful

use of the tube, it is possible to employ it without serious difficulty with the most delicate patients, and even children.

As regards the inconvenience to the physician, I cannot speak so encouragingly, for nothing short of a very thorough, painstaking, and most exact chemical investigation is of the slightest value. Indeed, the information afforded by a careless investigation might be most unfortunate and damaging by giving a wrong direction to the treatment. The most precise chemical methods and the most careful and dexterous manipulation will alone give satisfactory results. A mere qualitative analysis is of no value whatever, as has already been shown. An exact quantitative determination of the chlorine in its several states must be made. For this, a properly equipped laboratory and a skilled chemist, or at least one who is skilled in the particular methods required in quantitative analysis, are requisite. The time required for the careful examination of a single specimen of stomach fluid is from three to five hours. Much of this time must be consumed in filtration and evaporation, and so three or four specimens can be examined at once without much increasing the time spent. It must not be imagined, however, that when an analysis has been made and the diagnosis and therapeutic indications worked out, all has been accomplished that a stubborn case requires. It is often necessary to make repeated analyses, varying the character of the test meal and the time of the digestion. Above all, it is necessary that a careful dietetic prescription shall be made, and that the patient shall be made to carry it out. The difficulties in the way of inducing the patient to take the dietetic part of his prescription, are sometimes very great, but the thing must be accomplished, even if it becomes necessary to send the patient away from home to some place where his dietetic needs may be supplied, or to hire a special cook or nurse to supervise his dietary. At whatever cost, the thing must be done, and not in a half-hearted way, but most thoroughly, or the effort will be fruitless. I find that patients are always deeply interested in the results of the chemical investigation of the stomach fluid, and a careful physical examination of the stomach by clapotement and other means. Patients who have long suffered from stomach disorders recognize at once the

value of this mode of investigation, and are very ready to bear uncomplainingly the slight inconvenience of the method, feeling that an effort is being made to reach the root of the difficulty which has occasioned them so much discomfort and suffering. The ability to represent graphically by a formula the exact condition of the digestive process in a given case, and to determine mathematically the extent of deviation from the normal condition, relieves the subject of functional disorders of the stomach from the mystic vagueness with which it has been surrounded heretofore, and illuminates every case thus investigated with a light which renders the study really a fascinating one to both patient and physician. The graphic character of the method and its exactness have suggested that it might be termed the "algebra of the stomach." Certainly no algebraic problem could be more interesting than are the problems in digestion which this method enables one to solve readily, and with a high degree of precision.

In my own experience, I think I have demonstrated that most of the therapeutic indications encountered in functional disorders of the stomach may be fully met by careful and intelligent regulation of the diet with the aid of the information afforded by the chemical investigation of stomach fluids, and by a skillful application of the various therapeutic means afforded by hydrotherapy, massotherapy, electrotherapeutics, and a few medicinal agents. Peptones, pepsine, and other digested foods and digestants I have almost wholly discarded, and I believe with advantage. Indeed, in reviewing the results in the treatment of more than 10,000 cases of stomach disorders, I can find very few instances in which more than temporary benefit has been derived from the use of these agents. I hope to be able soon to publish a report of the results of a series of exact experiments which clearly define the precise value of this class of remedies.

There is still, however, a great dearth of knowledge respecting the dietetic properties of various food substances and preparations. The observations of Beaumont upon the stomach of Alexis St. Martin afford about the only reliable information possessed by the profession at the present time; but unfortunately, this ingenious investigator was unacquainted with the

facts which have been developed by modern physiology, and especially by bacteriology, and hence his observations were necessarily crude and his results conflicting and uncertain. As a matter of fact, we know almost nothing about the digestibility of foods or the special therapeutic values of different food substances. I am now engaged in an extensive series of experiments upon healthy persons, which I trust will afford definite and positive information, since the exact chemical methods which we now possess enable us to study the digestive process in all its stages with nearly the same precision that the assayer studies the handful of crude ore brought him by the prospector, and with results as brilliant as those which sometimes reward the mine hunter among the mountains of the West.

The results of my studies, together with an outline of the methods of treatment which I have found successful in the management of functional disorders of the stomach, I shall make the subject of other papers.